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R-33-8-90-10

FINAL
FIELD OPERATIONS PLAN

UNITS 5, 10, 16, AND 17

MARINE CORPS AIR STATION
CHERRY POINT, NORTH CAROLINA

CONTRACT NUMBER N62470-84-C-6886

NUS PROJECT NUMBER 7095

OCTOBER 1990

CP-00402-3.05-10/1/90

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SUBMITTED FOR NUS BY:

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

TABLES

FIGURES

1.0 INTRODUCTION

1.1 PURPOSE

This Field Operations Plan (FOP) is being issued as part of a RCRA Facility Investigation (RFI) and Corrective Measures Study (CMS) for the Department of the Navy, Atlantic Division for the Marine Corps Air Station (MCAS), Cherry Point, RFI Units 5, 10, 16, and 17, in response to a request by the Department of the Navy. This FOP was prepared under contract N62470-84-C-6886 and will be implemented under contract N62470-90-C-7635. As specified in the Draft Work Plan, Revision 1, (Work Plan) (NUS, updated May 1990), which outlines the technical scope and schedule for Phase I RFI and CMS activities, preparation of the FOP is designated as Subtask 1.3 in the Work Plan and is included under Task 1, Project Planning. The activities described in this document generally fall under Task 3, Field Investigation, in the Work Plan, as well as Task 4, Sample Analysis and Data Validation.

The FOP for Phase I work includes sampling and analytical objectives; the number, type and location of all samples to be collected during the field investigation; site-specific quality assurance requirements; and detailed procedures for field activities. The field activities specified in the FOP are based upon data gaps identified from evaluating the results of previous sampling activities (discussed in Section 1.2). The sampling and analytical procedures outlined in this FOP will provide data needed to define present and future risks to human health and the environment, associated with contamination at the MCAS, as well as to evaluate potential remedial alternatives.

Included in Appendix B of the FOP is the Health and Safety Plan (HASP). The HASP includes site-specific information on health and safety requirements, a hazard assessment, training requirements, monitoring procedures for site operations, safety and disposal procedures, and other requirements.

1.2 BACKGROUND

The Work Plan for RFI Units 5, 10, 16 and 17 was initially prepared as part of the Installation Restoration Program (IRP) at MCAS, Cherry Point, North Carolina. The first program objective was to collect and evaluate historical evidence indicating existence of pollutants that may have contaminated the installation or that pose an imminent health hazard on or off the facility. The Initial Assessment Study (IAS) (Water and Air Research, Inc., March 1983), which is essentially equivalent to a Preliminary Assessment conducted by the EPA under the Superfund Program, accomplished this goal by identifying 14 suspect units. The second objective of the program was to determine via sampling and analysis activities whether specific toxic and hazardous materials identified in the IAS, and possibly other contaminants, exist in concentrations considered to be hazardous. The Remedial Investigation Interim Report (NUS, November 1988), known previously as the Verification Step Report, summarized the installation of monitoring wells; sampling and analysis of groundwater, soils, and sediments; and data evaluation. As a result, the report identified RFI Units 5, 10, 16, and 17 as contaminated and requiring additional investigation.

Subsequent to these units being identified by the Navy as areas of concern, a Consent Order under 3008(h) was issued to the Navy by the EPA. This order requires that work be conducted under the auspices of RCRA. Because of this, RCRA terminology has been incorporated into this FOP (i.e., RCRA Facility Investigation, Corrective Measures Study, RFI Unit, etc.). The balance of project activities will be conducted to comply with the requirements of the Consent Order.

1.3 SITE LOCATION AND DESCRIPTION

The Marine Corps Air Station (MCAS), Cherry Point is part of a military installation located in southeastern Craven County, North Carolina, just north of Havelock. The site is located on a 11,485-acre tract of land bounded on the north by the Neuse River estuary, the east by Hancock Creek, and the south by North Carolina Highway 101. The irregular western boundary line lies approximately 3/4 mile west of the Slocum Creek. The entire area is located on a peninsula with Core and Bogue Sounds to the south. Refer to the vicinity map shown in Figure 1-1, which also identifies outlying parts of the military installation, such as the Marine Corps Auxiliary Landing Field (MCALF) Bogue, Marine Corps Outlying Landing Field (MCOLF) Atlantic, and Point of Marsh Bombing Range. Summaries of the site history, environmental setting, and existing contaminant data are included in the Work Plan (NUS, May 1990), more detailed site information can be found in the following documents:

- IAS Report (Water and Air Research, 1983).
- Remedial Investigation Interim Report (NUS, November 1988).
- Hydrogeologic Setting, Water Levels and Quality of Supply Wells at MCAS, Cherry Point (Lloyd and Daniel, 1988).
- Hydrogeologic and Water-Quality Data From Well Clusters Located Near the Wastewater Treatment Plant (Murray and Daniel, 1988).

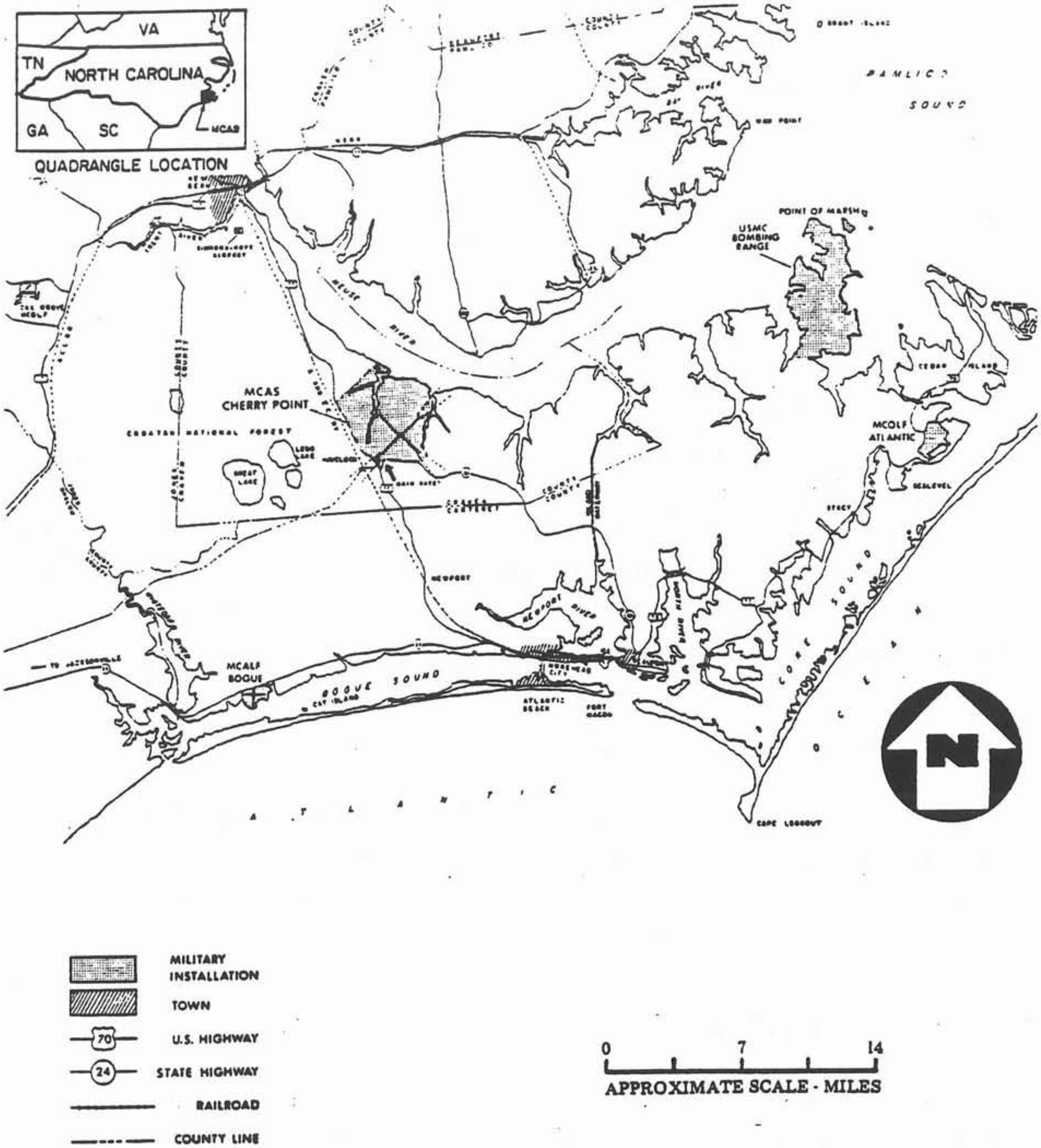


FIGURE 1-1

VICINITY MAP
MCAS CHERRY POINT, NC

NUS CORPORATION

- Results-Groundwater Assessment (Environmental and Safety Designs, Inc., 1988).

- Soil Sampling and Analysis, 100,000-Gallon Tank Site (General Engineering Laboratories, 1988).

Figure 1-2 presents a location map identifying the four RFI Units of concern within the MCAS vicinity; RFI Units 5, 10, 16 and 17. The following subsections describe these specific units.

1.3.1 RFI Unit 5 - Storage Tanks for Waste Petroleum, Oil, and Lubricant (POL)

RFI Unit 5 consists of Tank No. 1771 (100,000-gallon capacity) and the immediate area. It is adjacent to a dismantled steam power plant and Slocum Creek. The potentially contaminated area includes a 20-foot-wide strip around Tank 1771 and a 30-foot-wide strip, 150 feet long, between the tank and Slocum Creek. However, Tank No. 1771 has not been definitely identified as the source of contamination. Also located in the area is Tank 1129, a 1.5-million gallon tank previously used for No. 6 fuel oil storage. This tank is no longer used and is scheduled for demolition in the near future. Figure 1-3 shows the general unit configuration.

1.3.2 RFI Unit 10 - Old Sanitary Landfill

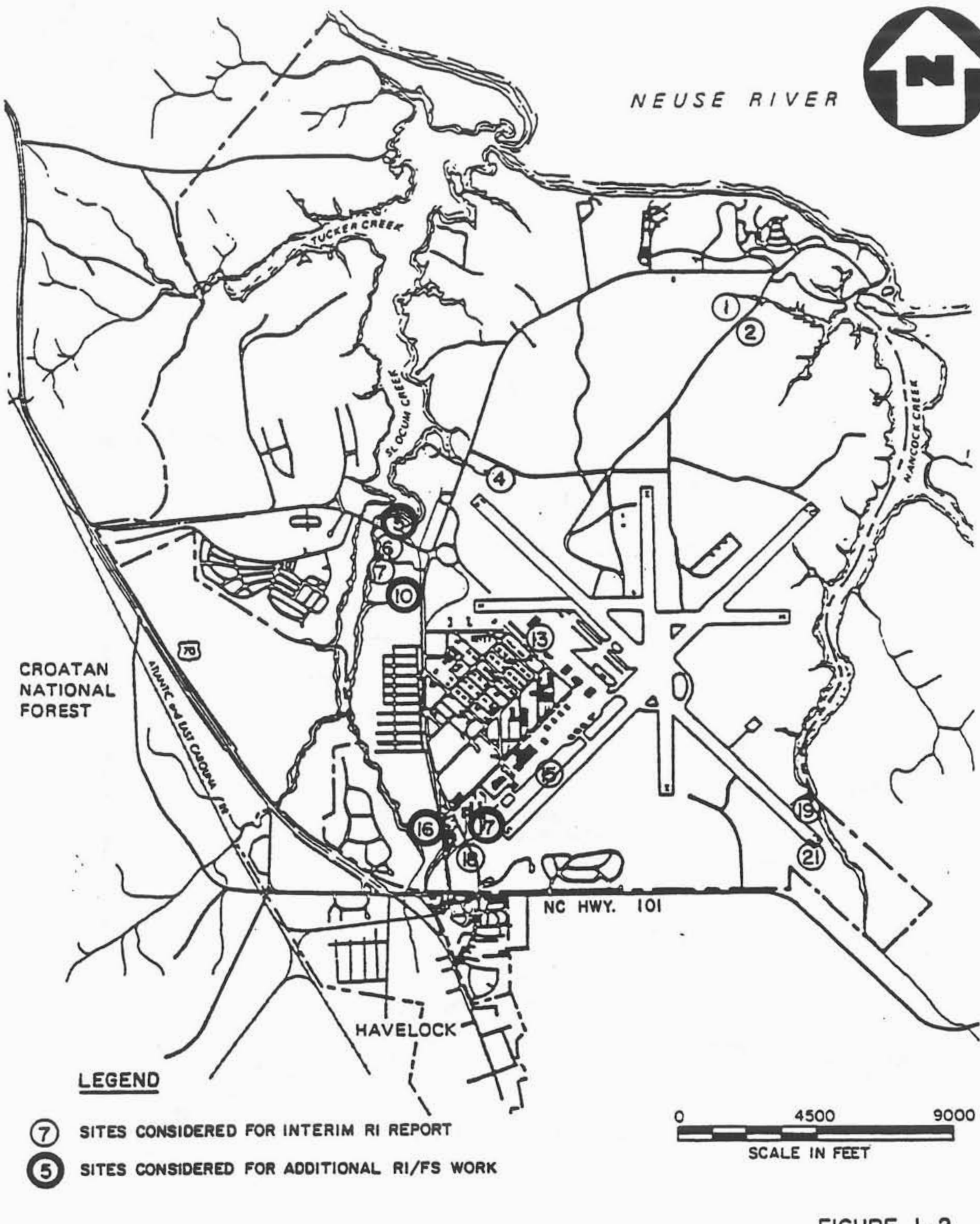
RFI Unit 10 is an old sanitary landfill located west of Roosevelt Boulevard and south of the Sewage Treatment Plant, as shown in Figure 1-4. The unit is bisected by Turkey Gut and lies adjacent to Slocum Creek. This landfill, which received all waste types generated at MCAS, Cherry Point, covers approximately 40 acres.

1.3.3 RFI Unit 16 - Landfill at Sandy Branch

RFI Unit 16 is a landfill located on Slocum Creek adjacent to and just south of Sandy Branch. Based on 1949 aerial photography, an approximate 11-acre area was used for what appeared to be a storage yard. Figure 1-5 depicts the general arrangement of the unit.

1.3.4 RFI Unit 17 - Defense Reutilization and Marketing Office (DRMO)

RFI Unit 17 is a waste storage facility located south of Building 155, as shown in Figure 1-6. It includes an area of approximately 1 acre and an associated drainage ditch perpendicular to the railroad. The ditch flows east toward Schoolhouse Branch which then flows to Slocum Creek.



LEGEND

7 SITES CONSIDERED FOR INTERIM RI REPORT

5 SITES CONSIDERED FOR ADDITIONAL RI/FS WORK

FIGURE 1-2

SITE LOCATION MAP
MCAS CHERRY POINT, NC

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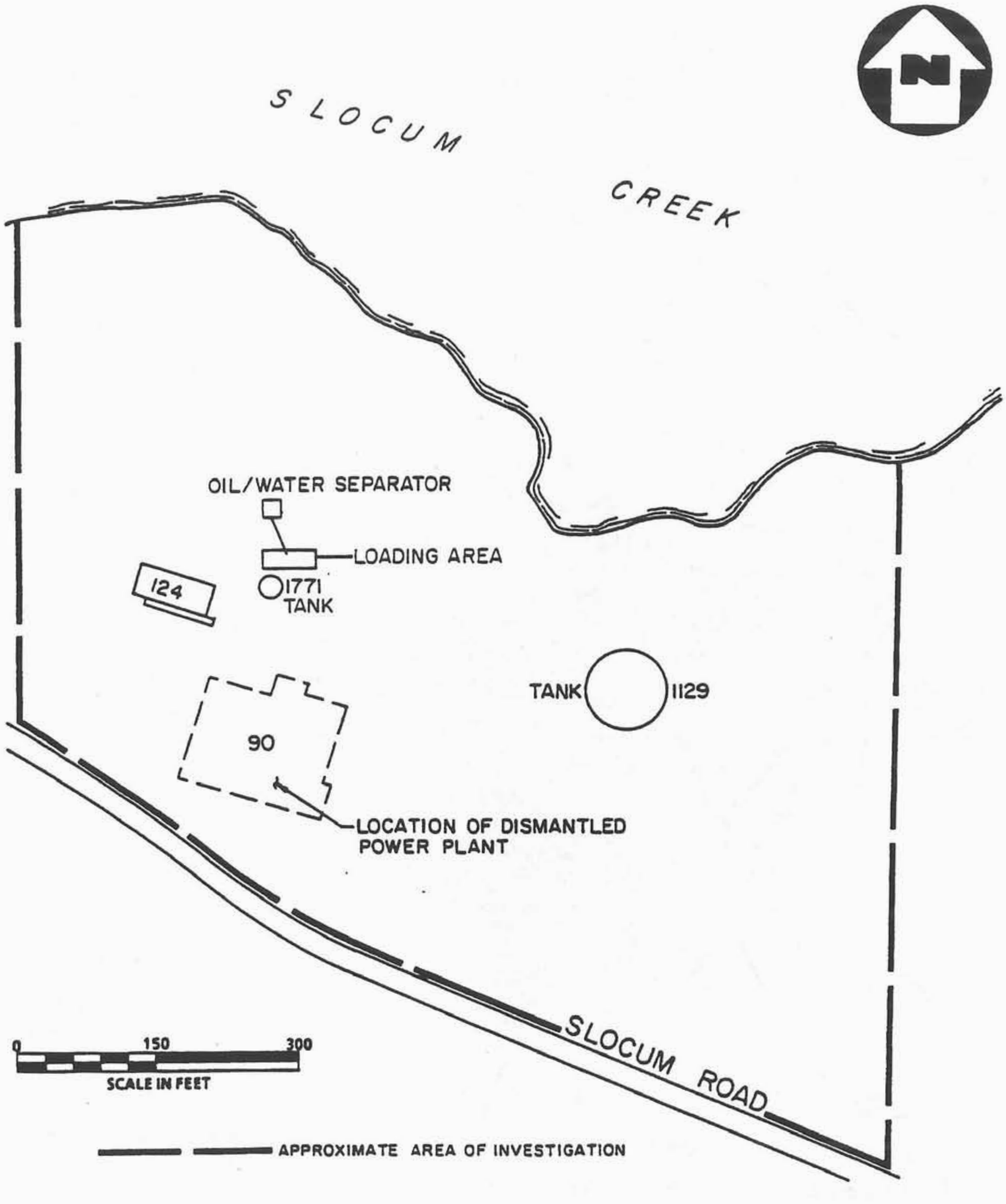

SITE 5
GENERAL ARRANGEMENT
MCAS CHERRY POINT, NC

FIGURE 1-3

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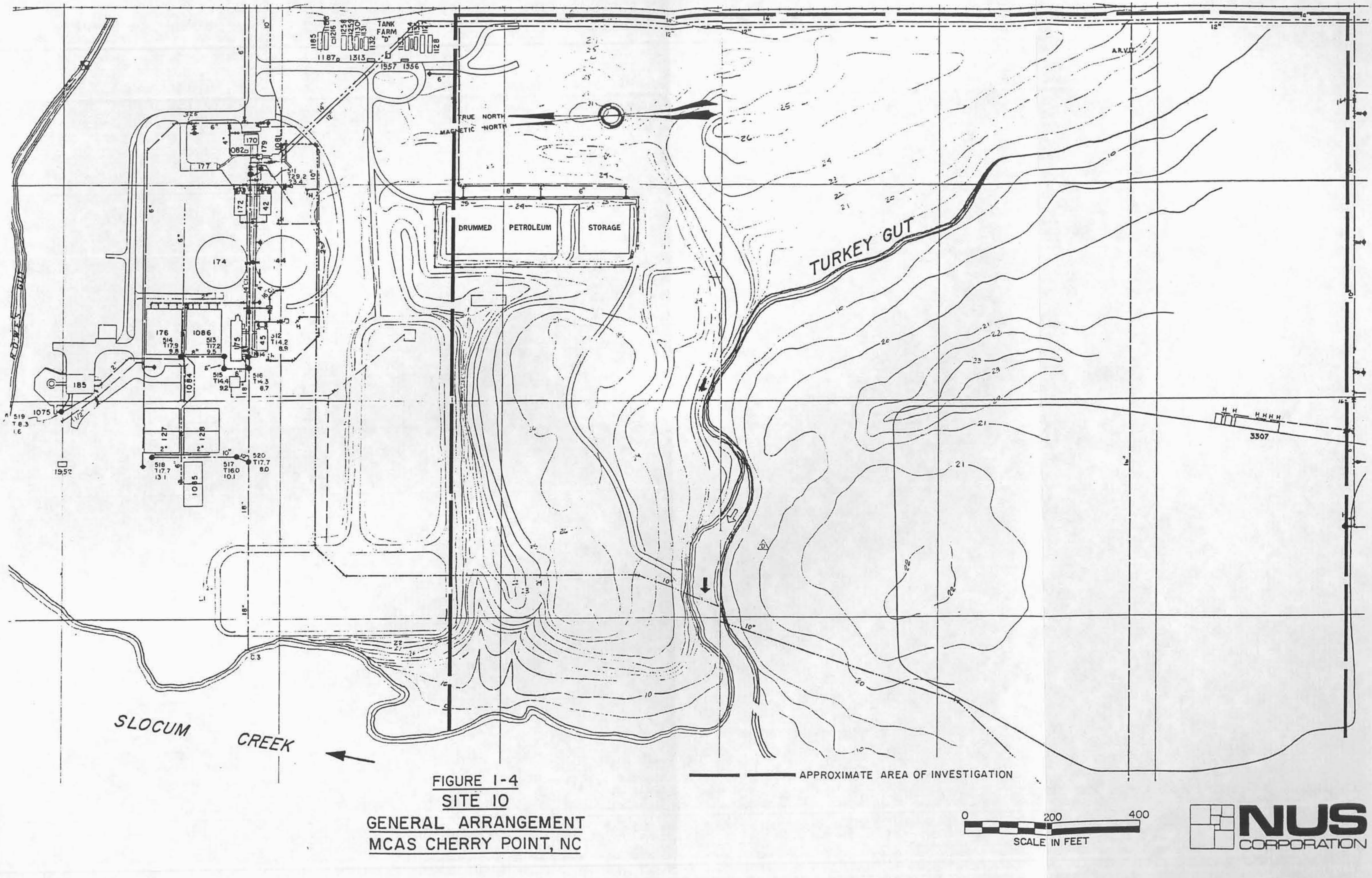
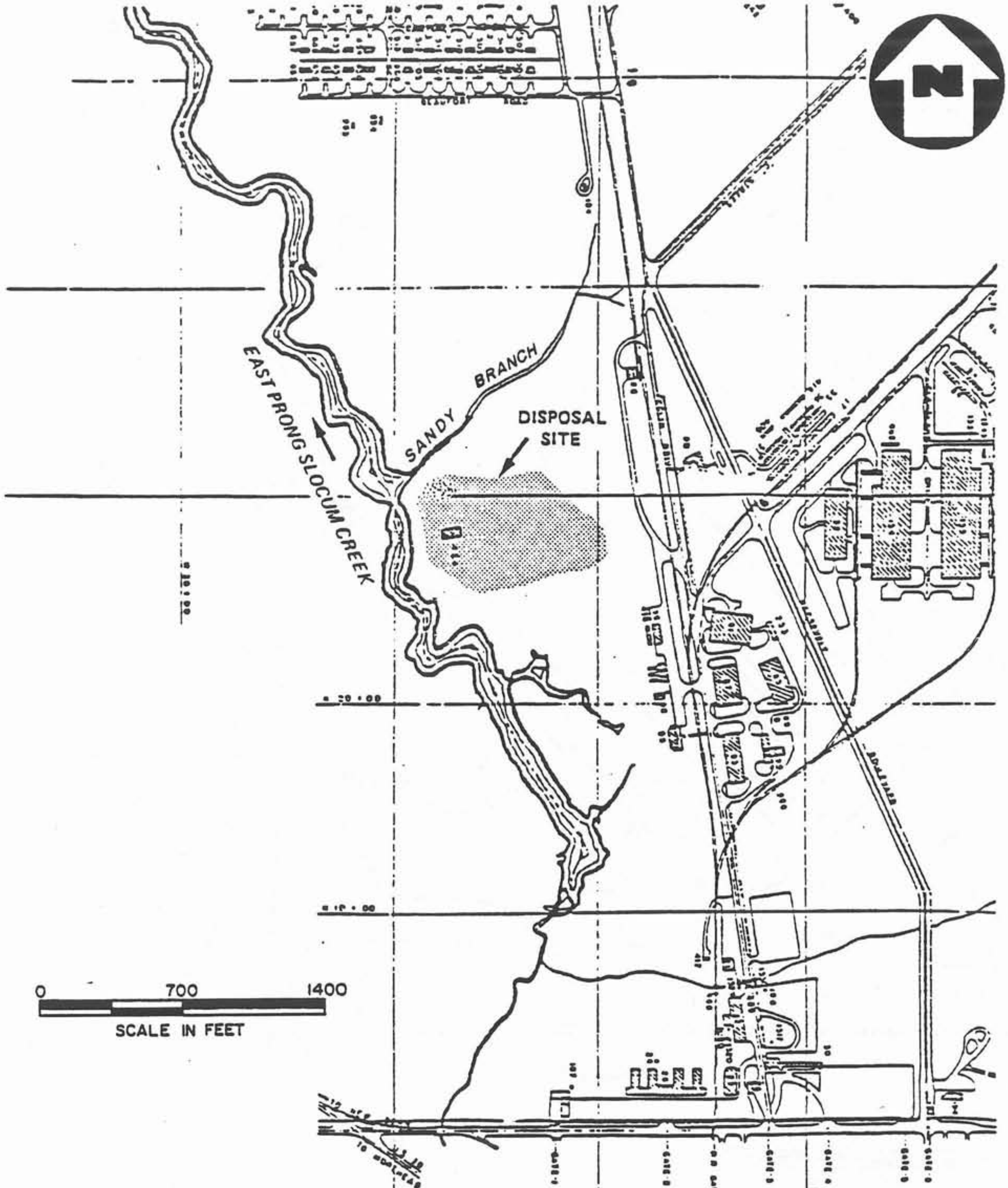


FIGURE 1-4
SITE 10
GENERAL ARRANGEMENT
MCAS CHERRY POINT, NC



SITE 16
GENERAL ARRANGEMENT
MCAS CHERRY POINT, NC

FIGURE 1-5

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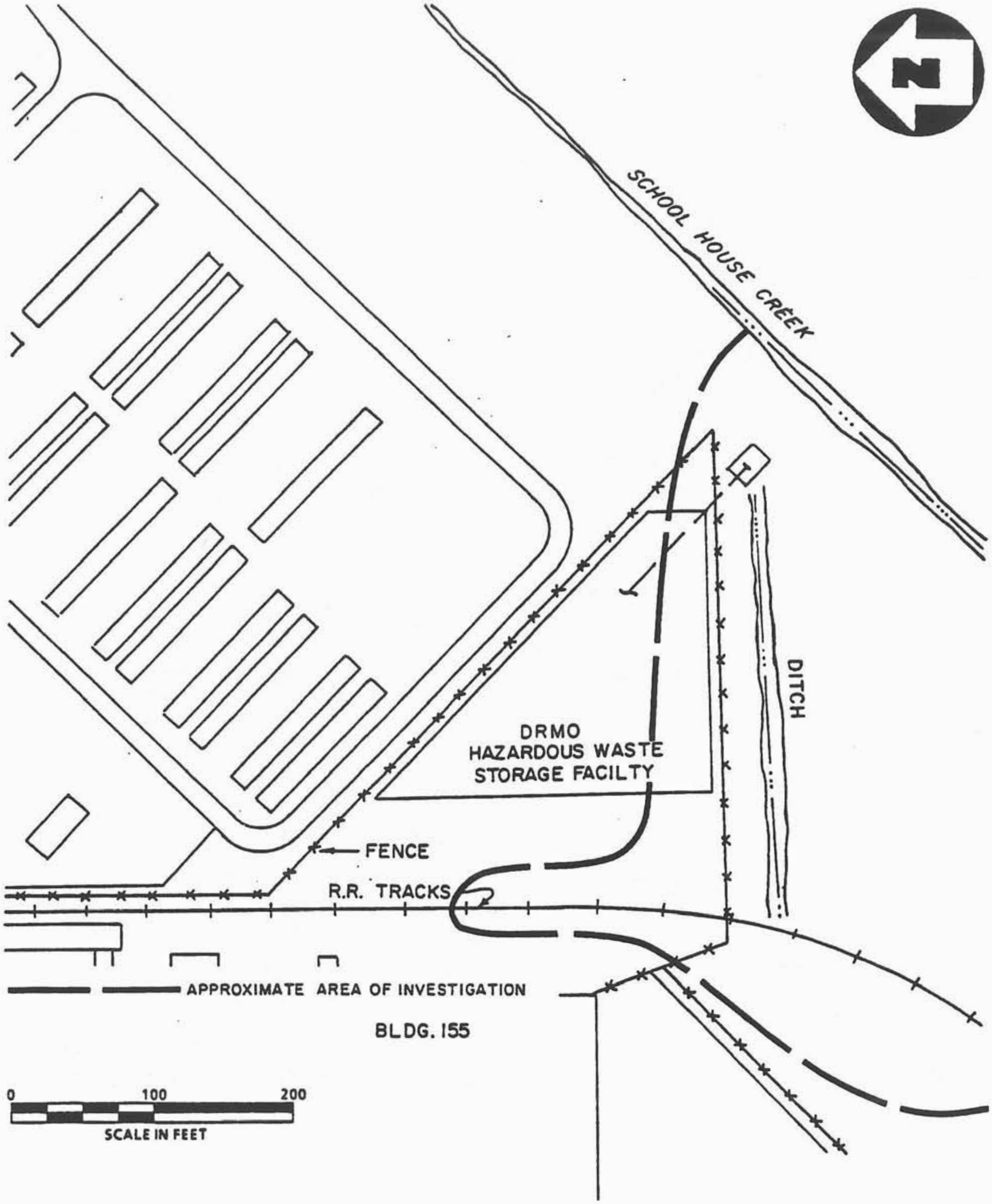

SITE 17
GENERAL ARRANGEMENT
MCAS CHERRY POINT, NC

FIGURE 1-6

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2.0 UNIT-SPECIFIC FIELD INVESTIGATION ACTIVITIES

This sections outlines the various field investigation and sampling activities for RFI Units 5, 10, 16, and 17 as follows:

- Section 2.1 - RFI Unit 5 Field Activities
- Section 2.2 - RFI Unit 10 Field Activities
- Section 2.3 - RFI Unit 16 Field Activities
- Section 2.4 - RFI Unit 17 Field Activities

The discussion in these sections focuses on hydrogeologic investigation and media sampling activities that are unique to each RFI Unit. General drilling and sampling specifications that are common to all RFI Units are discussed in Section 3.0, Sampling Procedures and Field Investigation Operations. For example, location-specific information such as soil boring depths, is included in this section, whereas drilling methods common to all soil borings are presented in Section 3.0.

2.1 RFI UNIT 5 FIELD ACTIVITIES

2.1.1 Surveying Operations

The locations of all new soil borings and monitoring wells will be surveyed following their installation. A total of 18 soil borings (5B01-5B18) and 4 monitoring wells (5GW08-5GW11), shown in Figures 2-1a and 2-1b, will be surveyed. In addition, the relative positions of the following items will be observed and recorded in the field notebook:

- Tank 1771.
- Tank 1129.
- Dismantled Building 90.
- Transformer station.
- Drainage swales.
- Vegetated areas.
- Shoreline.
- Area of partial remediation of PCB-contaminated soils (Navy personnel will identify this area to NUS sampling team).

2.1.2 Drilling Operations

2.1.2.1 Soil Boring Installation

A total of 18 soil borings will be installed at RFI Unit 5. The locations of the proposed soil borings are shown in Figures 2-1a and 2-1b. One or more samples will be collected from each of the borings for chemical analysis. None of the 18 soil borings at RFI Unit 5 will be converted to monitoring wells. All of the borings will be backfilled with bentonite following sampling. Additional drilling procedures are presented in Section 3.3.3. Soil boring numbers, depths, and location descriptions are shown in Table 2-1. Most of the soil borings shown in Table 2-1 are relatively shallow (3 to 8 feet), since the purpose of these borings is to obtain subsurface soil samples for chemical analysis. Soil borings 5B01, 5B02, 5B03, and 5B04 are drilled to deeper depths (approximately 40 feet) in order to locate the depth of the confining layer. Split-spoon sampling intervals for the borings are given in Section 2.1.3.3.

2.1.2.2 Monitoring Well Installation and Testing

A total of 4 new monitoring wells will be installed at RFI Unit 5. The locations of the proposed monitoring wells are shown in Figures 2-1a and 2-1b. No split-spoon soil samples will be taken during installation of the well borings. Additional monitoring well construction/installation procedures are presented in Section 3.3.4. Monitoring well numbers, depths, well screen intervals, and location descriptions are presented in Table 2-2. One round of samples will be collected from the new wells (and existing wells) for chemical analysis as described in Section 2.1.3.1. Well development and aquifer testing (slug tests), will be performed on each new well as described in Sections 3.3.5 and 3.3.6, respectively. One round of synoptic water-level measurements will be obtained from all existing wells (5GW01-5GW07) and new wells (5GW08-5GW11) within a 4-hour period as described in Section 3.3.7. A second round of water-level measurements will be performed on each new well within a 24-hour period as described in Section 3.3.7. Continuous water-level monitoring will also be performed on one of the new wells for a 1-week period as described in Section 3.3.7. A summary of the monitoring well installation and testing activities for RFI Unit 5 is given below:

- Install four shallow monitoring wells (5GW08-5GW11).
- Conduct a slug test on each new well.
- Obtain synoptic water-level measurements from all wells within a 4-hour period.
- Obtain a second round of water-level measurements from new wells within a 24-hour period.

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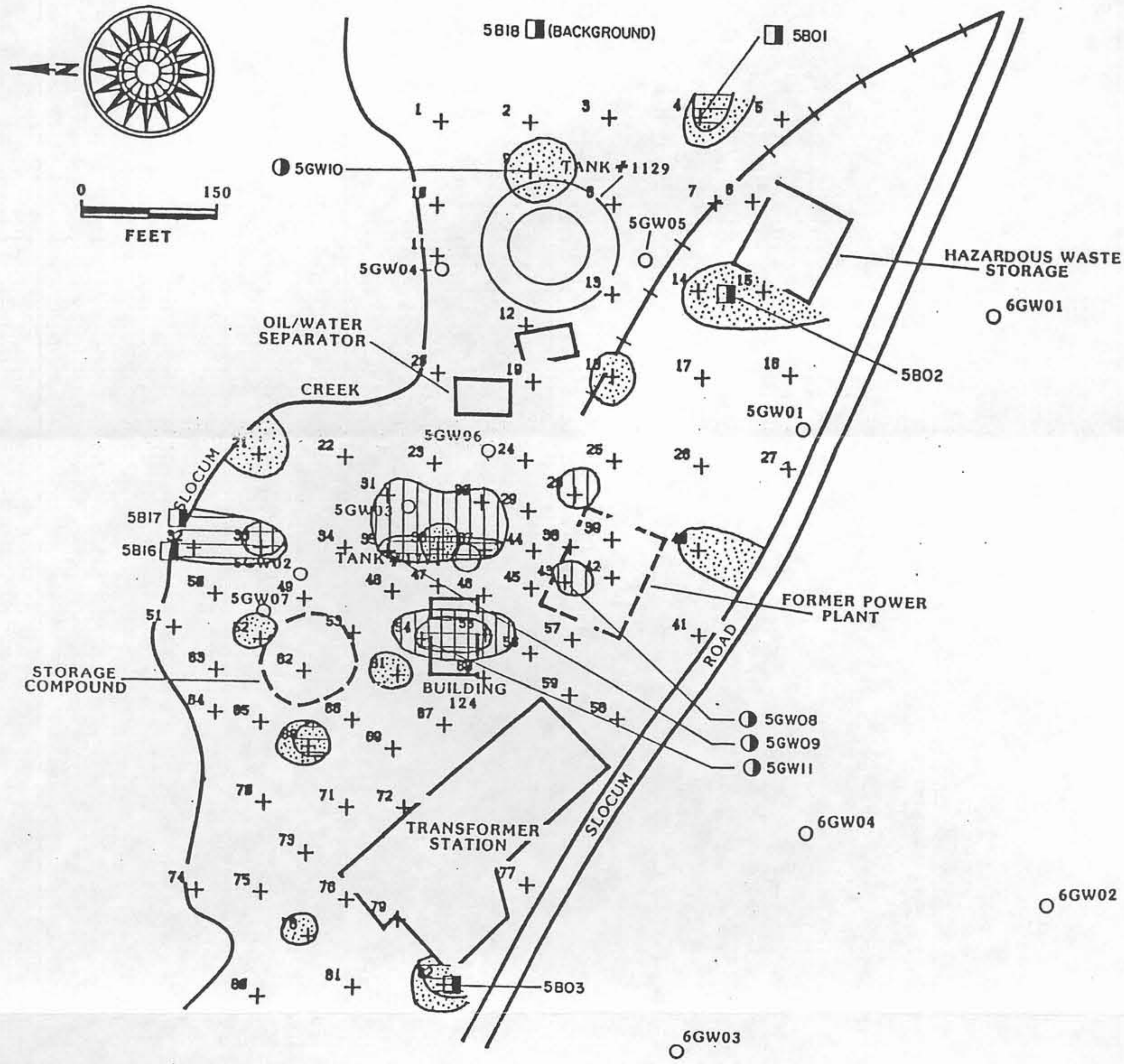


NOTE: 5B08 - 5B15 WILL BE DRILLED IN THE OIL/WATER SEPARATOR OUTFALL BETWEEN TANK 1771 AND SLOCUM CREEK.

LEGEND

+ PETREX COLLECTOR

PROPOSED BORING

MONITORING WELL

PROPOSED MONITORING WELL

ION COUNT ≥ 10,000

COMBINED HYDROCARBONS

TRICHLOROETHYLENE AND TETRACHLOROETHYLENE

DICHLOROETHANE / TRICHLOROETHANE AND FREON 11 & 113

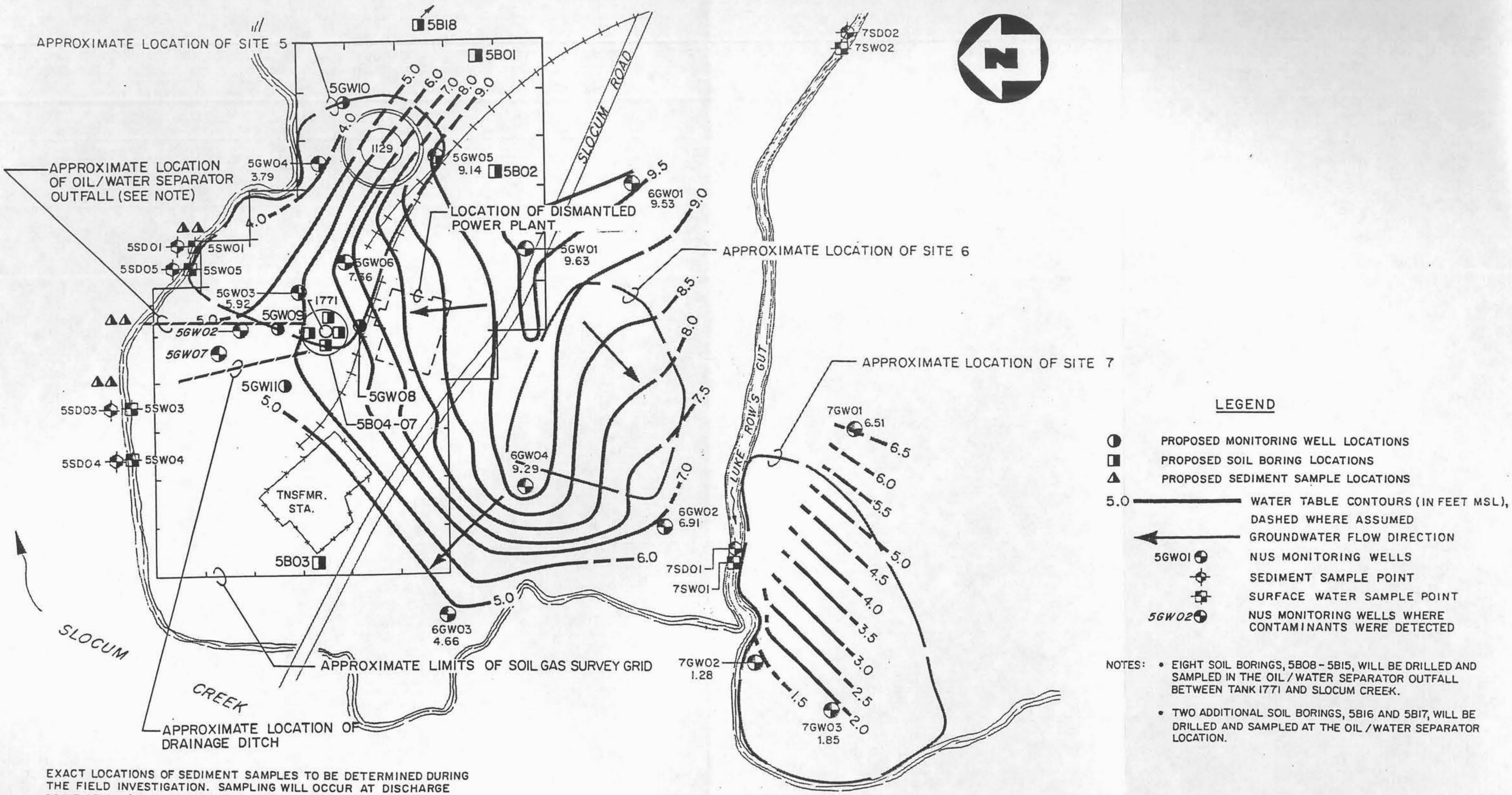
MARINE CORP AIR STATION

SITE 5

CHERRY POINT, NORTH CAROLINA

Peak Anomaly Zones and Soil Gas Collector Sample Locations

April 9, 1990 | Figure: 2-1a | Scale: 1in.= 150ft.



NOTES:
- EIGHT SOIL BORINGS, 5B08 - 5B15, WILL BE DRILLED AND SAMPLED IN THE OIL / WATER SEPARATOR OUTFALL BETWEEN TANK 1771 AND SLOCUM CREEK.
- TWO ADDITIONAL SOIL BORINGS, 5B16 AND 5B17, WILL BE DRILLED AND SAMPLED AT THE OIL / WATER SEPARATOR LOCATION.

EXACT LOCATIONS OF SEDIMENT SAMPLES TO BE DETERMINED DURING THE FIELD INVESTIGATION. SAMPLING WILL OCCUR AT DISCHARGE POINT OF OIL/WATER SEPARATOR OUTFALL AND 100 FT. IN BOTH DIRECTIONS FROM THE DISCHARGE POINT.

SITE 5
PROPOSED SAMPLING LOCATIONS (PHASE I)
AND GROUNDWATER CONTOUR MAP
MCAS CHERRY POINT, NC

FIGURE 2-1b

0 200 400
SCALE IN FEET

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TABLE 2-1

RFI UNIT 5
SOIL BORING INSTALLATION DETAILS
MCAS, CHERRY POINT, NORTH CAROLINA

Soil Boring Number	Boring (Auger) Depth(1) (Feet)	Location
5B01	40 (approximate)(2)	Soil gas location No. 4
5B02	40 (approximate)(2)	Soil gas location No. 14 & 15
5B03	40 (approximate)(2)	Soil gas location No. 82
5B04	40 (approximate)(2)	Near Tank No. 1771
5B05	8	Near Tank No. 1771
5B06	8	Near Tank No. 1771
5B07	8	Near Tank No. 1771
5B08	3	Between Tank No. 1771 and Slocum Creek
5B09	3	Between Tank No. 1771 and Slocum Creek
5B10	3	Between Tank No. 1771 and Slocum Creek
5B11	3	Between Tank No. 1771 and Slocum Creek
5B12	3	Between Tank No. 1771 and Slocum Creek
5B13	3	Between Tank No. 1771 and Slocum Creek
5B14	3	Between Tank No. 1771 and Slocum Creek
5B15	3	Between Tank No. 1771 and Slocum Creek
5B16	8	Near oil/water separator
5B17	8	Near oil/water separator
5B18	8	Background

(1) Boring depth is depth to which auger is drilled; does not include additional depth of any split-spoon or thin-wall tube samples taken at bottom of bore hole.

(2) Boring will be drilled to depth of confining layer (approximately 30-50 feet).

TABLE 2-7

RFI UNIT 5
LABORATORY ANALYSIS OF SEDIMENT SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses[b]
PCBs	CLP[a]	C	6
Total Organic Carbon (TOC)	SW 9060	E	6

(a) CLP - Contract Laboratory Program.
(b) Does not include QA/QC samples (see Section 3.2.2).

2.1.3 Media Sampling Operations

The following media will be sampled at RFI Unit 5:

- Groundwater
- Floating product (if encountered)
- Subsurface soil
- Sediment

The sample identification system used for the media is presented in Section 3.2.1. Sample handling, packaging and shipping, and documentation are discussed in Sections 3.2.2, 3.2.3, and 3.2.4, respectively. With respect to the quality of data needed to support the RFI and CMS activities, a Data Quality Objective (DQO) Level C will be used for all samples. Protocols for DQO Level C are described in Section 9.0 of the "NUS Corporation Laboratory Quality Assurance Plan in support of the Department of the Navy Requirements for Quality Control of Analytical Data."

2.1.3.1 Groundwater Sampling

One round of groundwater samples will be taken from six existing wells (5GW01, 5GW02, 5GW03, 5GW04, 5GW05, and 5GW07) and four newly installed wells (5GW08, 5GW09, 5GW10, and 5GW11). Groundwater sampling locations are shown in Figures 2-1a and 2-1b. The laboratory analysis of groundwater samples is summarized in Table 2-3. All of the monitoring wells will be analyzed for the following parameters:

- TCL volatiles
- PCBs
- Total Suspended Solids (TSS)
- Total Petroleum Hydrocarbons

In addition to the parameters listed above, groundwater from wells 5GW01, 5GW08, 5GW09, 5GW10, and 5GW11 will be analyzed for:

- Total Organic Carbon (TOC):

TABLE 2-3

RFI UNIT 5
LABORATORY ANALYSIS OF GROUNDWATER SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses (C)
TCL Volatiles(a)	CLP(b)	C	10
PCBs	CLP(b)	C	10
Total Suspended Solids (TSS)	EPA 160.2	E	10
Total Organic Carbon (TOC)	EPA 415.1	E	5 (1)
Total Petroleum Hydrocarbons	EPA 418.1	E	10

(a) TCL = Target Compound List.
(b) CLP = Contract Laboratory Program.
(c) Does not include QA/QC samples (see Section 3.2.2).
PCBs Polychlorinated biphenyls.
(1) Wells 5GW01, 5GW08, 5GW09, 5GW10, 5GW11 (one sample per well).

If a floating product layer is detected in the shallow monitoring wells (5GW07, 5GW08, 5GW09, 5GW10, 5GW11), samples of the floating product will be collected and analyzed as described in the following section.

2.1.3.2 Floating Product

If a floating product layer is detected in any of the shallow monitoring wells (5GW07, 5GW08, 5GW09, 5GW10, 5GW11), a sample of the floating product will be collected from that well and analyzed for the parameters listed in Table 2-4.

2.1.3.3 Subsurface Soil Sampling

Details of split-spoon sampling and analyses are summarized in Table 2-5 for the 18 soil borings drilled at RFI Unit 5. Laboratory analyses of the subsurface samples are also outlined in Table 2-6. Soil sampling locations are shown in Figures 2-1a and 2-1b. Overburden drilling procedures and subsurface sampling guidelines are given in Section 3.3.3.

As shown in Table 2-5, laboratory analyses will only be conducted on the shallow subsurface soil samples (10 feet or less). With respect to the four borings that are to be drilled to the confining layer (5B01, 5B02, 5B03, and 5B04), the deeper split-spoon samples will be taken for lithologic description only, in order to locate the depth of the confining layer. Because the depth of the confining layer may vary throughout RFI Unit 5 (approximately 30-50 feet), the exact number and depths of the split-spoon samples required to locate the confining layer will be determined in the field by the site geologist. For Soil Borings 5B01-5B04, following collection of the shallow soil samples for laboratory analyses (0-10 feet), the next split-spoon sample will be taken at approximately 28-30 feet to locate the confining layer and then at 5-foot intervals, as shown in Table 2-5.

2.1.3.4 Sediment Sampling

A total of six sediment samples will be collected from Slocum Creek in the vicinity of the oil/water separator outfall. The six samples will be taken from three transects perpendicular to the bank of Slocum Creek approximately 100 feet apart. The three transect locations are shown in Figure 2-1b and are organized as follows:

- Two samples will be taken upgradient of the discharge point.
- Two samples will be taken at the discharge point.
- Two samples will be taken downgradient of the discharge point.

TABLE 2-4

RFI UNIT 5
LABORATORY ANALYSIS OF FLOATING PRODUCT SAMPLES (OPTIONAL)
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses [b]
PCBs	CLP[a]	C	5[c]
British Thermal Unit (BTU)	ASTM D3286	C	5[c]
Flashpoint	TBD	E	5[c]
Density	TBD	E	5[c]
Viscosity	TBD	E	5[c]

(a) CLP - Contract Laboratory Program.
(b) Does not include QA/QC samples (see Section 3.2.2).
(c) One sample per well will be taken only if floating product is encountered in that well (maximum 5 total samples).
PCBs Polychlorinated biphenyls.
TBD To Be Determined.

TABLE 2-5

RFI UNIT 5
SUBSURFACE SOIL SAMPLING DETAILS
MCAS, CHERRY POINT, NORTH CAROLINA

Soil Boring Number	Sampling Interval (Feet)	Sample Type	Analysis (Per Sample)
5B01, 5B02, 5B03	0.5 - 2.5	Split-spoon	TCL volatiles, PCBs, Total Petroleum Hydrocarbons (TPHs)
	28 - 30(1)	Split-spoon	None
	33 - 35(1)	Split-spoon	None
	38 - 40(1)	Split-spoon	None
5B04	0.5 - 2.5	Split-spoon	Full TCL organics and metals plus TPHs
	3.0 - 5.0	Split spoon	Full TCL organics and metals plus TPHs
	5.5 - 7.5	Split spoon	Full TCL organics and metals plus TPHs
	8.0 - 10.0	Split spoon	Full TCL organics and metals plus TPHs
	28 - 30(1)	Split spoon	None
	33 - 35(1)	Split spoon	None
	38 - 40(1)	Split spoon	None
5B05, 5B06, 5B07	0.5 - 2.5	Split-spoon	Full TCL organics and metals plus TPHs
	3.0 - 5.0	Split-spoon	Full TCL organics and metals plus TPHs
	5.5 - 7.5	Split-spoon	Full TCL organics and metals plus TPHs
	8.0 - 10.0	Split-spoon	Full TCL organics and metals plus TPHs
5B08, 5B09, 5B10, 5B11	1.0 - 3.0	Split-spoon	TCL volatiles
	1.0 - 3.0	Split-spoon	PCBs
	1.0 - 3.0	Split-spoon	Total Petroleum Hydrocarbons (TPHs)
	1.0 - 3.0	Split-spoon	Total Organic Carbon (TOC)
	1.0 - 3.0	Split-spoon	Density
	1.0 - 3.0	Split-spoon	Grain size
	1.0 - 3.0	Split-spoon	British Thermal Unit (BTU)
	3.0 - 5.0	Split-spoon	TCL volatiles, PCBs, TPHs

TABLE 2-5
RFI UNIT 5
SUBSURFACE SOIL SAMPLING DETAILS
MCAS, CHERRY POINT, NORTH CAROLINA
PAGE TWO

Soil Boring Number	Sampling Interval (Feet)	Sample Type	Analysis (Per Sample)
5B12, 5B13, 5B14, 5B15	1.0 - 3.0	Split-spoon	TCL volatiles, PCBs, TPHs, TOC
	3.0 - 5.0	Split-spoon	TCL volatiles, PCBs, TPHs
5B16, 5B17, 5B18	0.5 - 2.5	Split-spoon	Full TCL organics and metals plus TPHs
	3.0 - 5.0	Split-spoon	Full TCL organics and metals plus TPHs
	5.5 - 7.5	Split-spoon	Full TCL organics and metals plus TPHs
	8.0 - 10.0	Split-spoon	Full TCL organics and metals plus TPHs

(1) Actual sampling interval and number of split-spoon samples will be determined in the field by site geologist.

TABLE 2-6

RFI UNIT 5
LABORATORY ANALYSIS OF SUBSURFACE SOIL SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses(c)
Full TCL Organics and Metals*	CLP(a)	C	28 (1)
TCL Volatiles(b)	CLP(a)	C	19 (2)
PCBs	CLP(a)	C	19 (2)
Total Organic Carbon (TOC)	SW 9060	E	8 (3)
Density	Agronomy No. 9	E	4 (4)
Grain Size	ASTM D422	E	4 (4)
British Thermal Unit	ASTM D3286	E	4 (4)
Total Petroleum Hydrocarbons	SW3550/EPA 418.1	E	47 (5)

(a) CLP = Contract Laboratory Program.
(b) TCL = Target Compound List.
(c) Does not include QA/QC samples (see Section 3.2.2).
* Full TCL Organics and Metals are proposed for soil samples associated with RCRA closure of Tank 1771. Field QA/QC samples have been estimated for planning purposes.
(1) Four each from 5B04-5B07 and 5B16-5B18.
(2) Two each from 5B08-5B15, one each from 5B01, 5B02, 5B03.
(3) One each from 5B08-5B15 (1-3 foot interval).
(4) One each from 5B08-5B11 (1-3 foot interval).
(5) One each from 5B01-5B03, four each from 5B04-5B07 and 5B16-5B18, and two each from 5B08-5B15.

At each transect, a sample will be taken 2 feet and 4 feet from the edge of the bank. Specific sediment sampling procedures are discussed in Section 3.4.3. Laboratory analyses for the six samples are summarized in Table 2-7.

2.2 RFI UNIT 10 FIELD ACTIVITIES

2.2.1 Surveying Operations

The locations of all new soil borings and monitoring wells will be surveyed following their installation. A total of 4 soil borings (10B01-10B04) and 12 monitoring wells (10GW36-10GW47), shown in Figures 2-2a and 2-2b, will be surveyed.

2.2.2 Drilling Operations

2.2.2.1 Soil Boring Installation

A total of 4 soil borings will be drilled at RFI Unit 10 through the surface impoundment area. The locations of the proposed soil borings are shown in Figures 2-2a and 2-2b. Soil boring numbers, depths, and location descriptions are shown in Table 2-8. One or more samples will be collected from each of the borings for chemical analysis. The four borings will be backfilled with bentonite following sampling. Additional drilling procedures are presented in Section 3.3.3. Split-spoon sampling intervals for the borings are given in Section 2.2.3.2.

2.2.2.2 Monitoring Well Installation and Testing

A total of 12 new monitoring wells will be installed at RFI Unit 10. The locations of the proposed monitoring wells are shown in Figures 2-2a and 2-2b. Additional monitoring well construction/installation procedures are presented in Section 3.3.4. Monitoring well numbers, depths, well screen intervals, and location descriptions are presented in Table 2-9. As shown in Table 2-9, all wells will be installed to a depth of 25 feet. However, in order to locate the depth of the confining layer, 9 of the 12 well borings (10GW36, 10GW37, 10GW38, 10GW39, 10GW40, 10GW44, 10GW45, 10GW46, and 10GW47) will be drilled to an initial depth of approximately 40 feet and then backfilled with bentonite to the well depth (25 feet) after the confining layer has been located.

TABLE 2-7

RFI UNIT 5
LABORATORY ANALYSIS OF SEDIMENT SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses[b]
PCBs	CLP[a]	C	6
Total Organic Carbon (TOC)	SW 9060	E	6

(a) CLP - Contract Laboratory Program.
(b) Does not include QA/QC samples (see Section 3.2.2).

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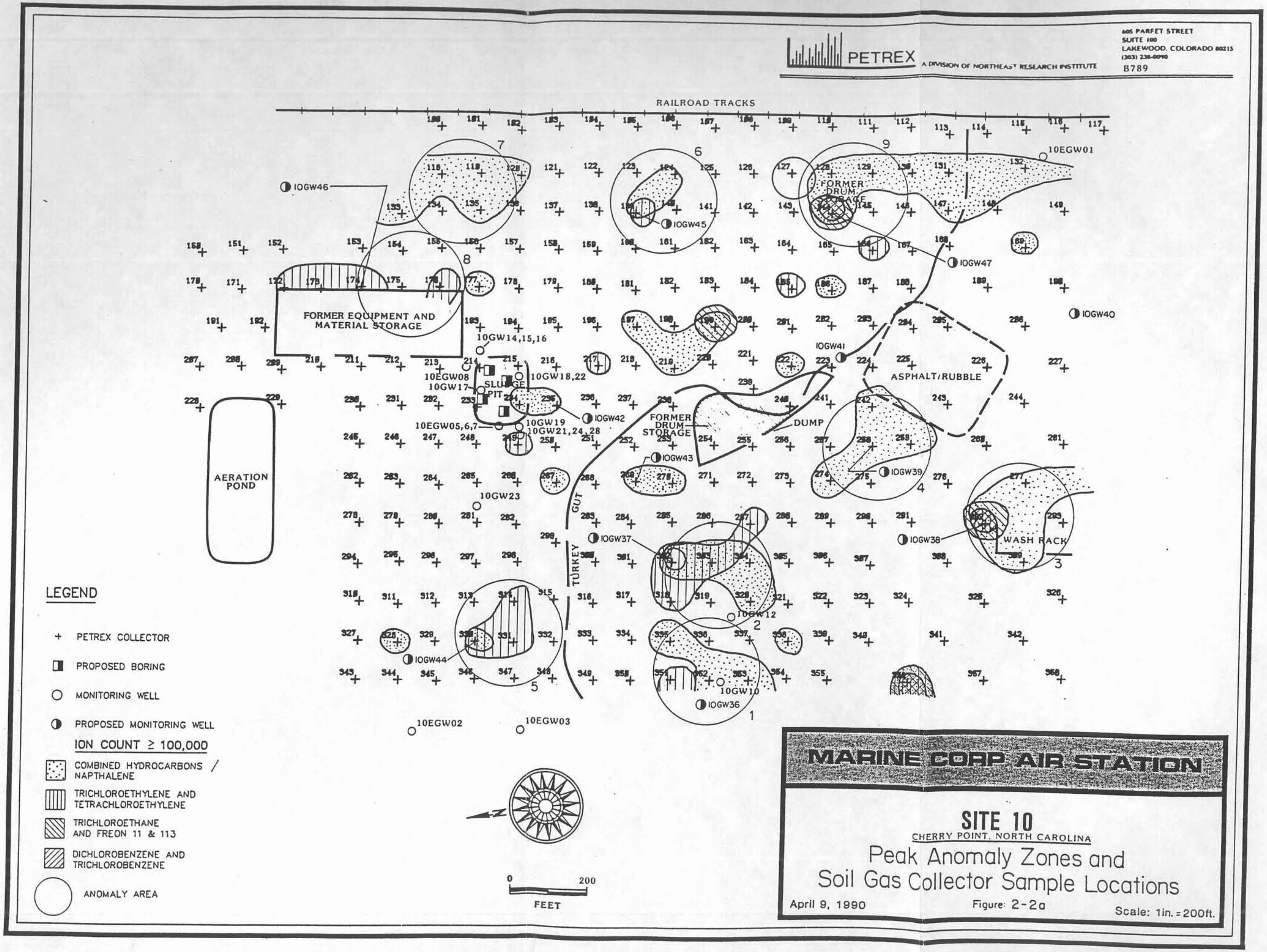

MARINE CORP AIR STATION

SITE 10

CHERRY POINT, NORTH CAROLINA

Peak Anomaly Zones and Soil Gas Collector Sample Locations

April 9, 1990 Figure: 2-2a Scale: 1in. = 200ft.

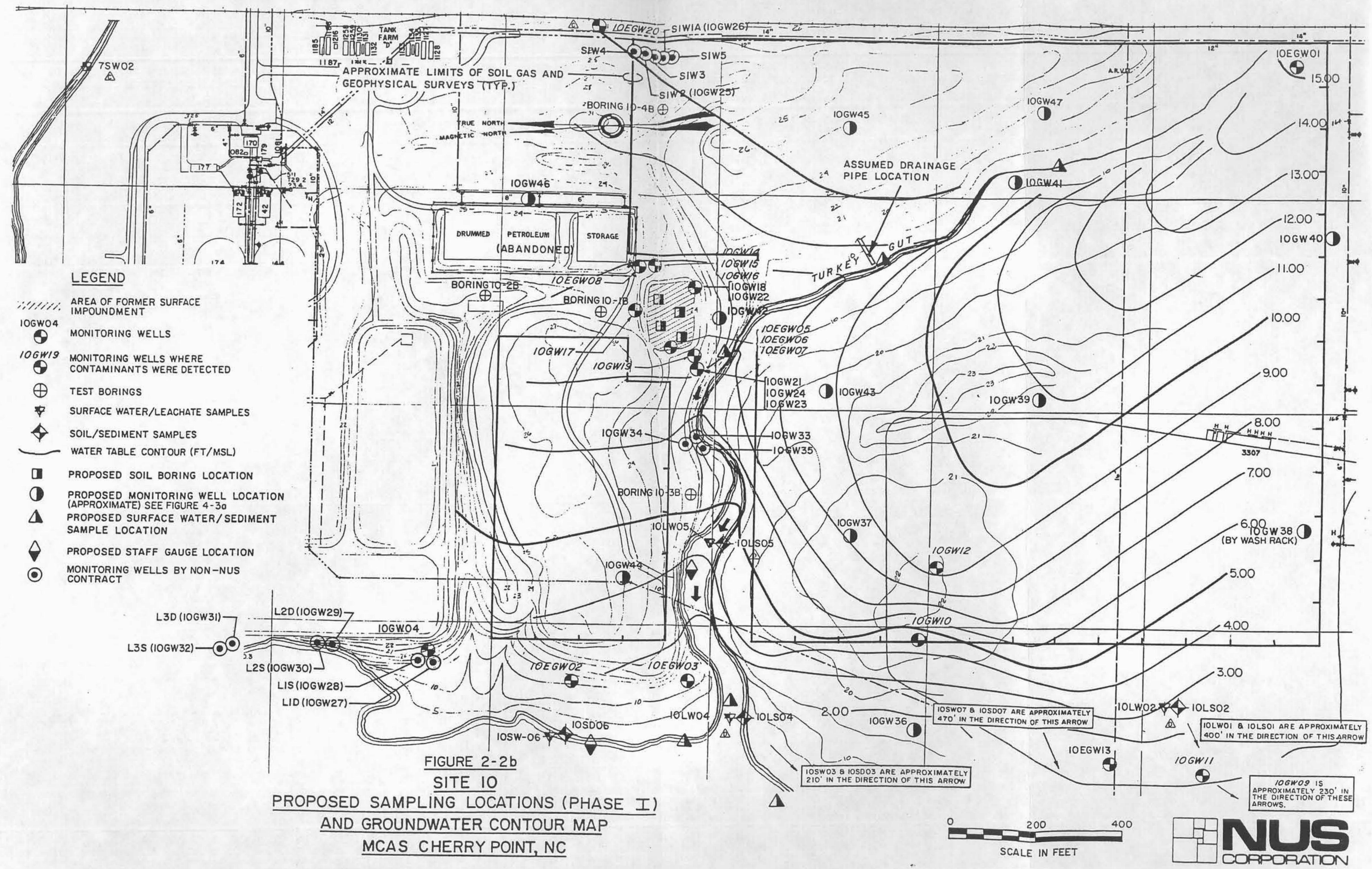

FIGURE 2-2b
SITE 10
PROPOSED SAMPLING LOCATIONS (PHASE I)
AND GROUNDWATER CONTOUR MAP
MCAS CHERRY POINT, NC

One round of samples will be collected from the new wells (and existing wells) for chemical analysis as described in Section 2.2.3.1. Well development and aquifer testing (slug tests) will be performed on each new well as described in Sections 3.3.5 and 3.3.6, respectively. One round of synoptic water-level measurements will be obtained from 23 existing wells (10GW01-10GW17, 10GW19-10GW21, and 10GW33-10GW35) and all new wells (10GW36-10GW47) within a 4-hour period as described in Section 3.3.7. A second round of water-level measurements will be performed on each new well within a 24-hour period as described in Section 3.3.7. Continuous water-level monitoring will also be performed on one of the new wells for a one week period as described in Section 3.3.7. A summary of the monitoring well installation and testing activities for RFI Unit 10 is given below:

- Install 12 monitoring wells (10GW36-10GW47).
- Conduct a slug test on each new well.
- Obtain synoptic water-level measurements from all wells within a 4-hour period.
- Obtain a second round of water-level measurements from new wells within a 24-hour period.
- Perform continuous water level monitoring on one new well for a one-week period.

2.2.2.3 Staff Gauge Installation

Two staff gauges will be installed at the locations shown in Figure 2-2b. One gauge will be placed in Turkey Gut and the other will be placed in Slocum Creek. At a minimum, water-level measurements will be recorded at each staff gauge 4 times throughout the field investigation and following storm events.

2.2.3 Media Sampling Operations

The following media will be sampled at RFI Unit 10:

- Groundwater
- Subsurface soil
- Surface water
- Sediment

The sample identification system used for the media is presented in Section 3.2.1. Sample handling, packaging and shipping, and documentation are discussed in Sections 3.2.2, 3.2.3, and 3.2.4, respectively. With respect to the quality of data needed to support the RFI and CMS activities, a Data Quality Objective (DQO) Level C will be used for all samples. Protocols for DQO Level C are described in Section 9.0 of the "NUS Corporation Laboratory Quality Assurance Plan in support of the Department of the Navy Requirements for Quality Control of Analytical Data."

2.2.3.1 Groundwater Sampling

One round of groundwater samples will be taken from 23 existing wells (10GW01-10GW17, 10GW19-10GW21, and 10GW33-10GW35) and 12 new wells (10GW36-10GW47). Groundwater sampling locations are shown in Figures 2-2a and 2-2b. The laboratory analysis of groundwater samples is summarized in Table 2-10. All of the monitoring wells will be analyzed for the following parameters:

- TCL volatiles
- Total metals (filtered/unfiltered)
- Total Suspended Solids (TSS)

In addition to the parameters listed above, groundwater from 8 existing wells (10GW01, 10GW04, 10GW09, 10GW12, 10GW13, 10GW14, 10GW19, and 10GW33) and all new wells (10GW36-10GW47) will be analyzed for:

- Total Organic Carbon (TOC)
- Biochemical Oxygen Demand (BOD) (5-day)

Groundwater from wells 10GW03 and 10GW36 will be analyzed for:

- TCL Base Neutral Acid (BNA) extractable compounds
- TCL pesticides/PCBs

2.2.3.2 Subsurface Soil Sampling

Details of split-spoon sampling and analyses are summarized in Table 2-11 for the 4 soil borings and 12 monitoring well borings installed at RFI Unit 10. Laboratory analyses of the subsurface samples are also outlined in Table 2-12. Soil sampling locations are shown in Figures 2-2a and 2-2b. Overburden drilling procedures and subsurface sampling guidelines are given in Section 3.3.3.

TABLE 2-10

RFI UNIT 10
LABORATORY ANALYSIS OF GROUNDWATER SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses (d)
TCL Volatiles(a)	CLP(b)	C	35
Priority Pollutant Metals (filtered/unfiltered)	(1)	C	70
Total Organic Carbon (TOC)	EPA 415.1	E	20 (2)
TCL BNA(a)(c)	CLP(b)	C	2 (3)
TCL Pesticides/ PCBs(a)	CLP(b)	C	2 (3)
Total Suspended Solids (TSS)	EPA 160.2	E	35
Biochemical Oxygen Demand (BOD) (5-day)	SM 507	E	20 (2)

(a) TCL = Target Compound List.
(b) CLP = Contract Laboratory Program.
(c) Base Neutral Acid Extractable Compounds.
(d) Does not include QA/QC samples (see Section 3.2.2).

(1)

Antimony	CLP 204.2	Mercury	CLP 245.1, CLP 245.5
Arsenic	CLP 206.2	Nickel	CLP 200.7
Beryllium	CLP 200.7	Selenium	CLP 270.2
Cadmium	CLP 200.7	Silver	CLP 272.1
Chromium	CLP 200.7	Thallium	CLP 279.2
Copper	CLP 200.7	Zinc	CLP 200.7
Lead	CLP 239.2		

(2) Wells 10GW01, 10GW04, 10GW09, 10GW12, 10GW13, 10GW14, 10GW19, 10GW33, and 10GW36-10GW47.
(3) Wells 10GW03 and 10GW36 (one sample per well).

TABLE 2-11

RFI UNIT 10
SUBSURFACE SOIL SAMPLING DETAILS
MCAS, CHERRY POINT, NORTH CAROLINA

Soil Boring/ Monitoring Well Number	Sampling Interval (feet)	Sample Type	Analysis
10B01	1-3	Split-spoon	TCL Volatiles (optional)(1)
	1-3	Split-spoon	TCL Metals (optional)(1)
	1-3	Split-spoon	Total Organic Carbon (TOC) (optional)(1)
	3-5	Split-spoon	TCL Volatiles
	3-5	Split-spoon	TCL Metals
	3-5	Split-spoon	TCL BNA compounds
	3-5	Split-spoon	TCL Pesticides/PCBs
	3-5	Split-spoon	Total Organic Carbon (TOC)
	3-5	Split-spoon	Cation Exchange Capacity (CEC)
	3-5	Split-spoon	British Thermal Unit (BTU)
10B02, 10B04	1-3	Split-spoon	TCL Volatiles (optional)(1)
	1-3	Split-spoon	TCL Metals (optional)(1)
	1-3	Split-spoon	Total Organic Carbon (TOC) (optional)(1)
	3-5	Split-spoon	TCL Volatiles
	3-5	Split-spoon	TCL Metals
	3-5	Split-spoon	Total Organic Carbon (TOC)
10B03	1-3	Split-spoon	TCL Volatiles (optional)(1)
	1-3	Split-spoon	TCL Metals (optional)(1)
	1-3	Split-spoon	Total Organic Carbon (TOC) (optional)(1)
	3-5	Split-spoon	TCL volatiles
	3-5	Split-spoon	TCL metals
	3-5	Split-spoon	TCL BNA compounds
	3-5	Split-spoon	TCL Pesticides/PCBs
	3-5	Split-spoon	Total Organic Carbon (TOC)
	3-5	Split-spoon	Cation Exchange Capacity (CEC)

TABLE 2-11
RFI UNIT 10
SUBSURFACE SOIL SAMPLING DETAILS
MCAS, CHERRY POINT, NORTH CAROLINA
PAGE TWO

Soil Boring/ Monitoring Well Number	Sampling Interval (feet)	Sample Type	Analysis
10GW36	28-30(2)	Split-spoon	None
	33-35(2)	Split-spoon	None
	38-40(2)	Split-spoon	None
	40-42(2)	Thin-wall tube	Porosity, Permeability
10GW37, 10GW38, 10GW39, 10GW40	28-30(2)	Split-spoon	None
	33-35(2)	Split-spoon	None
	38-40(2)	Split-spoon	None
10GW41, 10GW42, 10GW43	None	None	None
10GW44	28-30(2)	Split-spoon	None
	33-35(2)	Split-spoon	None
	38-40(2)	Split-spoon	None
	40-42(2)	Thin-wall tube	Porosity, Permeability
10GW45, 10GW46, 10GW47	28-30(2)	Split-spoon	None
	33-35(2)	Split-spoon	None
	38-40(2)	Split-spoon	None

(1) Split-spoon sample will be packaged for three analysis (TCL volatiles plus xylenes, TCL metals, and TOC) only if obvious evidence of contamination is observed in the sample. Optional samples may only be taken from any two of the four borings (i.e., maximum number of optional samples is two).

(2) Actual sampling interval and number of split-spoon sample will be determined in the field by the site geologist.

(3) Actual sampling interval is dependent on depth of confining layer (30-50 feet) and will be determined in the field by the site geologist.

TABLE 2-12

RFI UNIT 10
LABORATORY ANALYSIS OF SUBSURFACE SOIL SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses(d)
TCL Volatiles(a)	CLP(b)	C	6
TCL Metals(a)	CLP(b)	C	6
TCL BNA(c)	CLP(b)	C	2 (1)
TCL Pesticides/ PCBs	CLP(b)	C	2 (1)
Total Organic Carbon (TOC)	SW 9060	E	6
Cation Exchange Capacity (CEC)	SW 9081	E	2 (1)
British Thermal Unit (BTU)	ASTM D3286	E	1 (2)
Porosity	--	E	2 (3)
Permeability	SW9100	E	2 (3)

(a) TCL = Target Compound List.
(b) CLP = Contract Laboratory Program.
(c) Base Neutral Acid Extractable Compounds.
(d) Does not include QA/QC samples (see Section 3.2.2).

(1) Borings 10B01 and 10B03 (one sample per boring).
(2) One sample from Boring 10B01.
(3) Borings 10GW36 and 10GW44 (one sample per boring).

As shown in Table 2-11, two split-spoon samples will be taken from each of the soil borings (10B01-10B04). For each of the four borings, laboratory analyses will be conducted on the second split-spoon sample taken (3-5 feet) from each boring. For each boring, laboratory analysis for the first split-spoon sample (1-3 feet) is optional. Sample containers from this optional split-spoon sample will only be prepared for analysis if obvious evidence of contamination is observed in the sample. An optional sample will only be taken from any two of the four borings, however. In other words, a maximum number of two optional samples will be taken.

As shown in Table 2-11, split-spoon samples will only be taken from the nine monitoring well borings that are drilled to the confining layer (approximately 40 feet). No split-spoon samples will be taken from monitoring well borings which are drilled to 25 feet (10GW41, 10GW42, and 10GW43).

For the nine deep borings, the split-spoon samples will be taken for lithologic description only, in order to locate the depth of the confining layer. The first split-spoon sample will be taken at approximately 28-30 feet and then at approximately 5-foot intervals. Because the depth of the confining layer may vary throughout RFI Unit 10 (approximately 30-50 feet), the actual number and depths of the split-spoon samples required to locate this layer will be determined in the field by the site geologist. For borings 10GW36 and 10GW44, once the confining layer is located, a thin-wall tube sample will be taken from the confining layer and analyzed for porosity and permeability.

2.2.3.3 Surface Water Sampling

Surface water samples will be collected from a total of six locations in Turkey Gut and Slocum Creek as shown in Figure 2-2b. The laboratory analysis program for surface water is summarized in Table 2-13. All six surface water samples will be analyzed for the following parameters:

- TCL volatiles
- Total metals (filtered/unfiltered)
- Total Suspended Solids (TSS)

In addition to the parameters listed above, two of the six samples will be analyzed for hardness. One of these samples will be collected from the furthest upgradient location in Turkey Gut and the other from the location near the intersection of Turkey Gut and Slocum Creek (see Figure 2-2b).

TABLE 2-13

RFI UNIT 10
LABORATORY ANALYSIS OF SURFACE WATER SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses(c)
TCL Volatiles(a)	CLP(b)	C	6
Priority Pollutant Metals (filtered/unfiltered)	(1)	C	12
Total Suspended Solids (TSS)	EPA 160.2	E	6
Hardness	SM 314B	E	2 (2)

(a) TCL = Target Compound List.
(b) CLP = Contract Laboratory Program.
(c) Does not include laboratory QA/QC samples.

(1)

Antimony	CLP 204.2	Mercury	CLP 245.1, CLP 245.5
Arsenic	CLP 206.2	Nickel	CLP 200.7
Beryllium	CLP 200.7	Selenium	CLP 270.2
Cadmium	CLP 200.7	Silver	CLP 272.1
Chromium	CLP 200.7	Thallium	CLP 279.2
Copper	CLP 200.7	Zinc	CLP 200.7
Lead	CLP 239.2		

(2) One sample will be taken furthest upgradient of site in Turkey Gut (Figure 2-2b) and one sample at intersection of Turkey Gut and Slocum Creek (Figure 2-2b).

2.2.3.4 Sediment Sampling

Sediment samples will be collected from a total of six locations in Turkey Gut and Slocum Creek as shown in Figure 2-2b. The laboratory analysis program is summarized in Table 2-14. All six sediment samples will be analyzed for the following parameters:

- TCL volatiles
- Total metals
- Total Organic Carbon (TOC)

2.3 RFI UNIT 16 FIELD ACTIVITIES

2.3.1 Surveying Operations

The locations of all new soil borings and monitoring wells will be surveyed following their installation. A total of 10 soil borings (16B01-16B10) and 7 monitoring wells (16GW10-16GW16) will be surveyed. The locations of the proposed monitoring wells are shown in Figures 2-3a and 2-3b.

2.3.2 Drilling Operations

2.3.2.1 Soil Boring Installation

A total of 10 soil borings will be installed at RFI Unit 16 at various soil gas locations. Soil gas locations are shown in Figure 2-3a. Soil boring numbers, depths, and location descriptions are shown in Table 2-15. Six of the soil borings will be drilled to the water table or to a maximum (auger) depth of 8 feet; 16B02, 16B03, 16B05, 16B06, 16B07, and 16B08. The other four soil borings (16B01, 16B04, 16B09, and 16B10) will be drilled to deeper depths (approximately 40 feet) in order to locate the depth of the confining layer. All borings will be backfilled with bentonite following sampling. Additional drilling procedures are presented in Section 3.3.3. Split-spoon sampling intervals for the borings are given in Section 2.3.3.2. Soil samples from the borings will be collected and inspected visually and by HNu to determine the presence of buried waste (sludge lagoons or buried drums). Samples may be collected from any of the 10 soil borings for chemical analysis as described in Section 2.3.3.2. This sampling is considered optional.

TABLE 2-14

RFI UNIT 10
LABORATORY ANALYSIS OF SEDIMENT SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses[c]
TCL Volatiles[a]	CLP[b]	C	6
TCL Metals[a]	CLP[b]	C	6
Total Organic Carbon (TOC)	SW 9060	C	6

(a) TCL = Target Compound List.
(b) CLP = Contract Laboratory Program.
(c) Does not include QA/QC samples (see Section 3.2.2).

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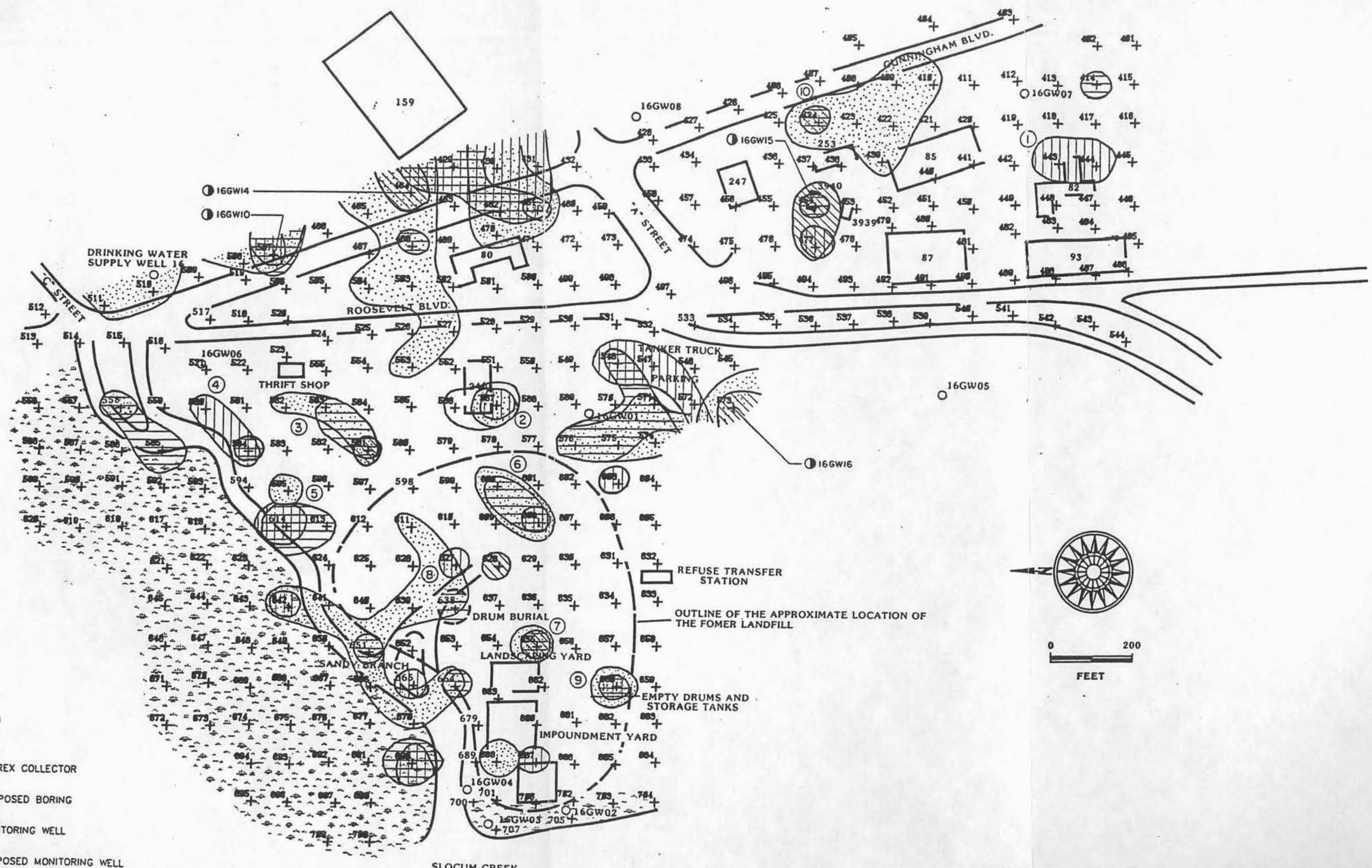


LEGEND

- \+ PETREX COLLECTOR
- PROPOSED BORING
- MONITORING WELL
- PROPOSED MONITORING WELL

ION COUNT ≥ 10,000

- COMBINED HYDROCARBONS
- TRICHLOROETHYLENE AND TETRACHLOROETHYLENE
- TRICHLOROETHANE AND FREONS
- DICHLOROETHYLENE
- SMALLER ANOMALY AREA

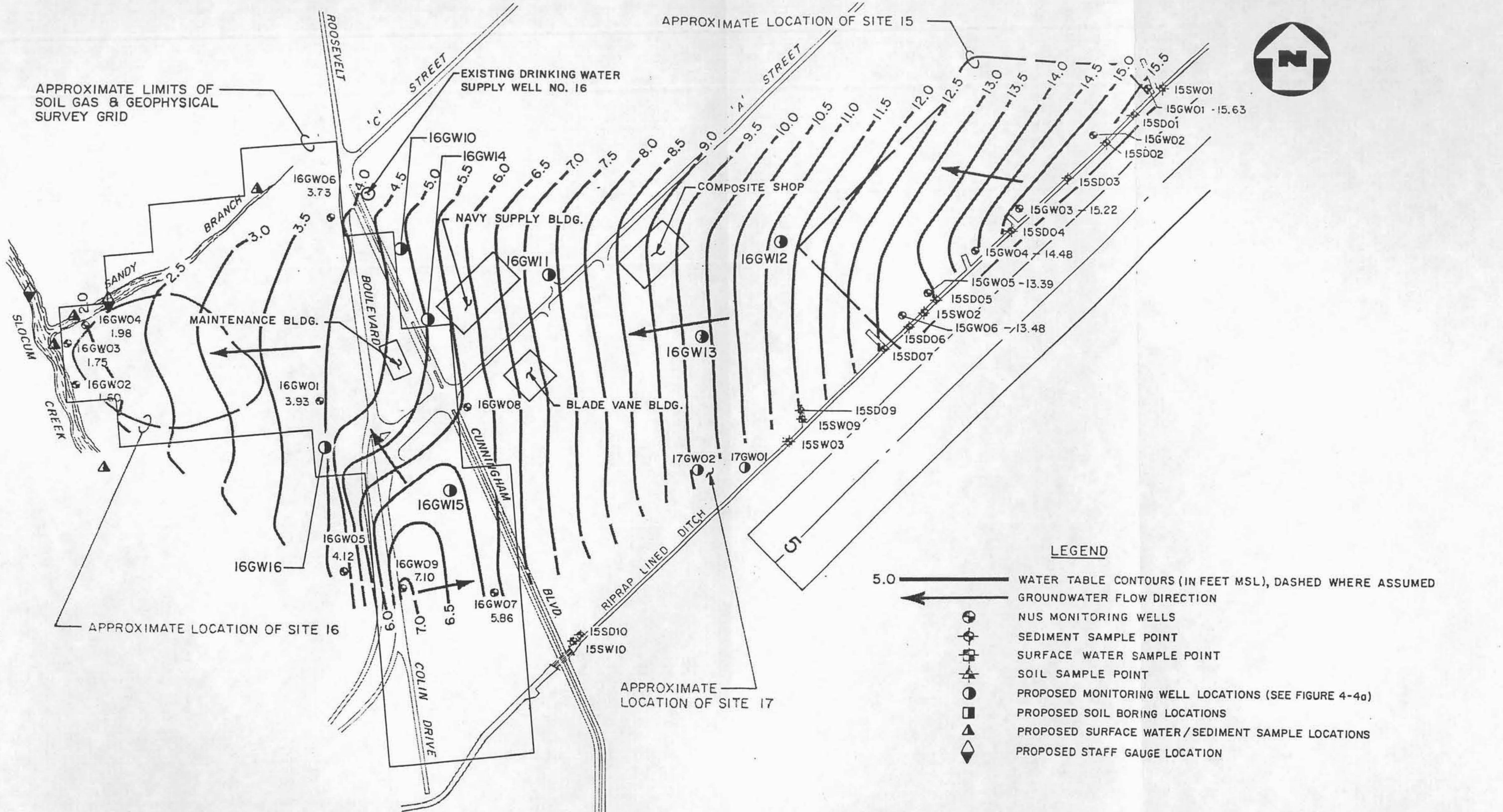
MARINE CORP AIR STATION

SITE 16

CHERRY POINT, NORTH CAROLINA

Peak Anomaly Zones and Soil Gas Collector Sample Locations

April 9, 1990 | Figure: 2-3a | Scale: 1in.= 200ft.



SITE 16
PROPOSED SAMPLING LOCATIONS (PHASE I)
AND GROUNDWATER CONTOUR MAP
MCAS CHERRY POINT, NC

FIGURE 2-3b

TABLE 2-15

RFI UNIT 16
SOIL BORING INSTALLATION DETAILS
MCAS, CHERRY POINT, NORTH CAROLINA

Soil Boring Number	Boring (Auger) Depth Feet(1)	Location
16B01	40 (approximate)(2)	Soil gas location No. 443
16B02	8 (approximate)(3)	Soil gas location No. 567
16B03	8 (approximate)(3)	Soil gas location No. 581
16B04	40 (approximate)(2)	Soil gas location No. 584
16B05	8 (approximate)(3)	Soil gas location No. 614
16B06	8 (approximate)(3)	Soil gas location No. 608
16B07	8 (approximate)(3)	Soil gas location No. 655
16B08	8 (approximate)(3)	Soil gas location No. 638
16B09	40 (approximate)(2)	Soil gas location No. 660
16B010	40 (approximate)(2)	Soil gas location No. 424

(1) Boring depth is depth to which auger is drilled; does not include additional depth of any split-spoon or thin-wall tube samples taken at bottom of bore hole.

(2) Boring will be drilled to depth of confining layer (approximately 30-50 feet).

(3) Boring will be drilled to water table up to a maximum depth of 8 feet.

2.3.2.2 Monitoring Well Installation and Testing

A total of 7 new monitoring wells will be installed at RFI Unit 16. The locations of the proposed monitoring wells are shown in Figures 2-3a and 2-3b. Additional monitoring well construction/installation procedures are presented in Section 3.3.4. Monitoring well numbers, depths, well screen intervals, and location descriptions are presented in Table 2-16. As shown in Table 2-16, all wells will be installed to a depth of 25 feet. However, in order to locate the depth of the confining layer, all well borings will be drilled to an initial depth of approximately 40 feet and then backfilled with bentonite to the well depth (25 feet) after the confining layer has been located. As discussed in Section 2.3.3.2, a thin-wall tube sample will be taken at the bottom of two monitoring well borings (16GW12 and 16GW16).

One round of samples will be collected from the 7 new wells (and all existing wells) for chemical analysis as described in Section 2.3.3.1. Well development and aquifer testing (slug tests), will be performed on each new well as described in Sections 3.3.5 and 3.3.6, respectively. One round of synoptic water-level measurements will be obtained from 9 existing wells (16GW01-16GW09) and all new wells (16GW10-10GW16) within a 4-hour period as described in Section 3.3.7. Because RFI Units 15 and 17 are located in close proximity to RFI Unit 16, the wells in these two RFI Units will be also included in the synoptic water-level measurements. Monitoring wells in RFI Unit 15 are shown in Figure 2-3c. A second round of water-level measurements will be performed on each new well in RFI Unit 16 within a 24-hour period as described in Section 3.3.7. A summary of the monitoring well installation and testing activities for RFI Unit 16 is given below:

- Install 7 monitoring wells (16GW10-16GW16).
- Conduct a slug test on each new well.
- Obtain synoptic water-level measurements from all wells within a 4-hour period (including wells in RFI Units 15 and 17).
- Obtain a second round of water-level measurements from new wells within a 24-hour period.

TABLE 2-16

RFI UNIT 16
MONITORING WELL INSTALLATION DETAILS
MCAS, CHERRY POINT, NORTH CAROLINA

Monitoring Well Number	Total Boring Depth (feet)	Well Depth (feet)	Riser Length (feet)	Screen Length (feet)	Location
16GW10	40 (approximate)(1)	25	12	15	Soil gas location No. 507
16GW11	40 (approximate)(1)	25	12	15	Near Navy supply building
16GW12	40 (approximate)(1)	25	12	15	Background
16GW13	40 (approximate)(1)	25	12	15	Behind composite shop
16GW14	40 (approximate)(1)	25	12	15	Soil gas location No. 464
16GW15	40 (approximate)(1)	25	12	15	Soil gas location No. 454
16GW16	40 (approximate)(1)	25	12	15	Soil gas location No. 573

(1) Boring will be drilled to depth of confining layer (approximately 30-50 feet). Boring will be backfilled with bentonite to well depth (25 feet).

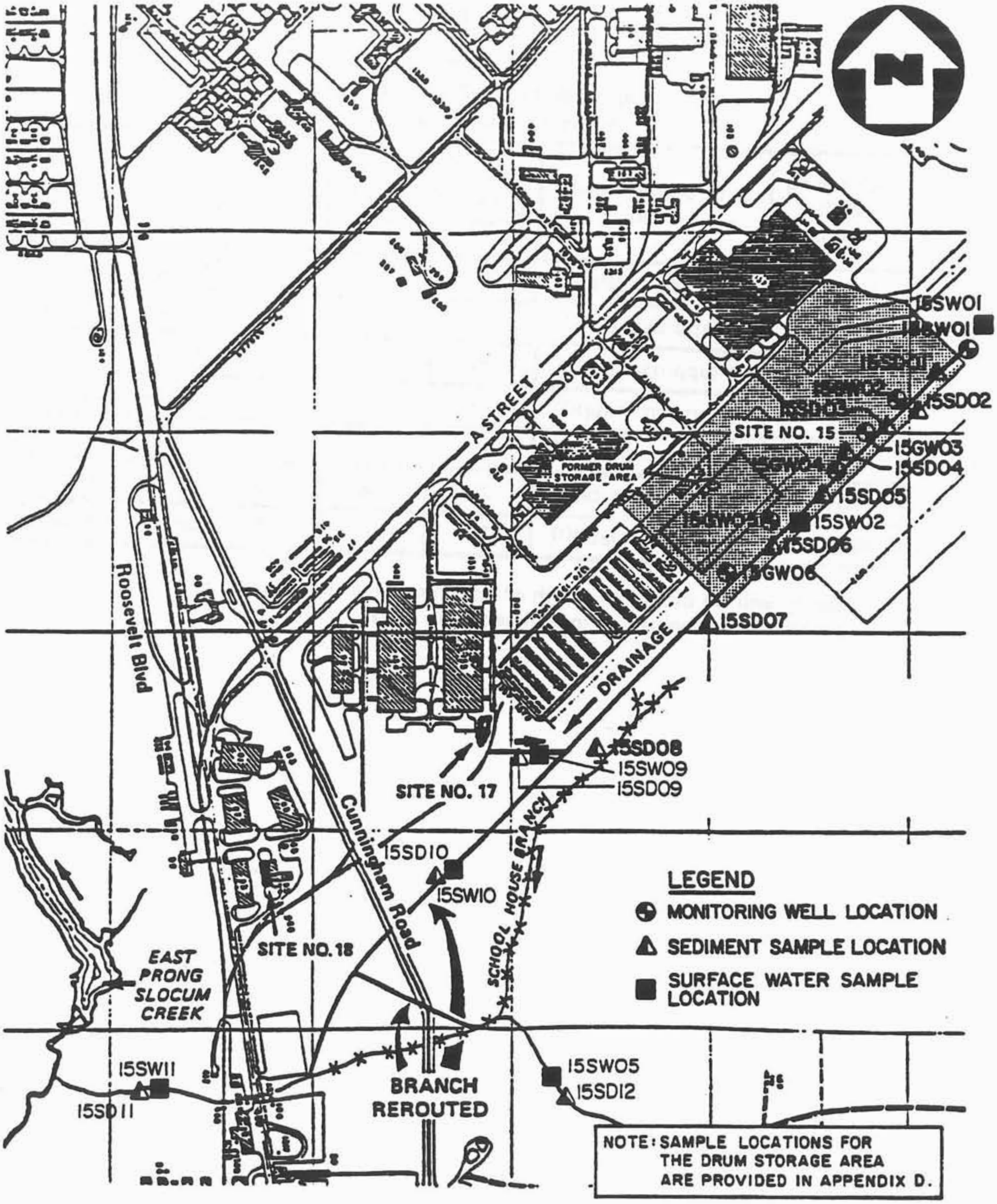


FIGURE 2-3c

EXISTING SAMPLING LOCATIONS AT RFI UNIT NO. 15

MCAS CHERRY POINT, NC

SCALE 1" = 675'

NUS CORPORATION

2.3.2.3 Staff Gauge Installation

Two staff gauges will be installed at the locations shown in Figure 2-3b. One gauge will be placed in Sandy Branch and the other will be placed in Slocum Creek. At a minimum, water-level measurements will be recorded at each staff gauge 4 times throughout the duration of the field investigation and following storm events.

2.3.3 Media Sampling Operations

The following media will be sampled at RFI Unit 16:

- Groundwater
- Subsurface soil
- Surface water
- Sediment

The sample identification system used for the media is presented in Section 3.2.1. Sample handling, packaging and shipping, and documentation are discussed in Sections 3.2.2, 3.2.3, and 3.2.4, respectively. With respect to the quality of data needed to support the RFI and CMS activities, a Data Quality Objective (DQO) Level C will be used for all samples. Protocols for DQO Level C are described in Section 9.0 of the "NUS Corporation Laboratory Quality Assurance Plan in support of the Department of the Navy Requirements for Quality Control of Analytical Data."

2.3.3.1 Groundwater Sampling

One round of groundwater samples will be taken from 10 existing monitoring wells (16GW01-10GW09 and either S3W2 or S3W3), one potable well (PW16) and 7 new wells (16GW10-16GW16). Groundwater sampling locations are shown in Figures 2-3a and 2-3b. The locations of S3W2 and S3W3 will be determined in the field. Since one of these two wells is equipped with a continuous water level recorder, the other will be sampled. The laboratory analysis of groundwater samples is summarized in Table 2-17. All of the monitoring wells will be analyzed for the following parameters:

- TCL volatiles
- Total metals (filtered/unfiltered)
- Total Suspended Solids (TSS)
- Cyanide

TABLE 2-17

RFI UNIT 16
LABORATORY ANALYSIS OF GROUNDWATER SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses[c]
TCL Volatiles[a]	CLP[b]	C	18
Priority Pollutant Metals (filtered/unfiltered)	(1)	C	36
Cyanide	EPA 335.2	C	18
Total Organic Carbon (TOC)	EPA 415.1	E	10 (2)
Total Suspended Solids (TSS)	EPA 160.2	E	18
Biochemical Oxygen Demand (BOD) (5-day)	SM 507	E	10 (2)

(a) TCL - Target Compound List.
(b) CLP - Contract Laboratory Program.
(c) Does not include QA/QC samples (see Section 3.2.2).

(1)

Antimony	CLP 204.2	Mercury	CLP 245.1, CLP 245.5
Arsenic	CLP 206.2	Nickel	CLP 200.7
Beryllium	CLP 200.7	Selenium	CLP 270.2
Cadmium	CLP 200.7	Silver	CLP 272.1
Chromium	CLP 200.7	Thallium	CLP 279.2
Copper	CLP 200.7	Zinc	CLP 200.7
Lead	CLP 239.2		

(2) Wells 16GW01, 16GW04, 16GW06, and 16GW10-16GW16.

In addition to the parameters listed above, groundwater from 3 existing wells (16GW01, 16GW04, and 16GW06) and all new wells (16GW10-16GW16) will be analyzed for:

- Total Organic Carbon (TOC)
- Biochemical Oxygen Demand (BOD) (5-day)

2.3.3.2 Subsurface Soil Sampling

Details of split-spoon sampling and analyses are summarized in Table 2-18 for the 10 soil borings and 7 monitoring well borings installed at RFI Unit 16. Laboratory analyses of the subsurface samples are also outlined in Table 2-19. Soil gas locations, which will be used to locate soil boring positions, are shown in Figure 2-3a. Overburden drilling procedures and subsurface sampling guidelines are given in Section 3.3.3.

As shown in Table 2-18, a minimum of two and a maximum of four split-spoon samples will be taken from each of the 6 shallow soil borings (16B02, 16B03, 16B05, 16B06, 16B07, and 16B08) depending on the depth to the water table. For the remaining 4 soil borings (16B01, 16B04, 16B09, and 16B10), which will be drilled to the confining layer (approximately 40 feet), this sampling strategy will also apply to the upper 10 feet of the boring. For the deeper portions of these 4 soil borings, the next split-spoon sample will be taken at approximately 28-30 feet and then at approximately 5-foot intervals. Because the depth of the confining layer may vary throughout RFI Unit 16 (approximately 30-50 feet), the actual number and depths of the split-spoon samples required to locate the confining layer will be determined in the field by the site geologist.

Soil samples taken from the shallow portions (upper 10 feet) of the 10 soil borings (16B01-16B10) will be collected and inspected visually and by HNu to determine the presence of buried waste (sludge lagoons or buried drums). If positive HNu readings occur during inspection of these 10 borings, soil samples can be obtained and analyzed for TCL volatile organics. This sampling and analysis is considered optional. Pictures will also be taken of specific samples to record the visual appearance for future reference. Split-spoon samples taken from the deeper portions (below 28 feet) of the 4 deep soil borings (16B01, 16B04, 16B09, and 16B10) will be taken for lithologic description only, in order to locate the depth of the confining layer.

As shown in Table 2-18, split-spoon samples will also be taken from the 7 monitoring well borings to be drilled to the confining layer (approximately 40 feet). For these 7 borings, the first split-spoon sample will be taken at approximately 28-30 feet and then at approximately 5-foot intervals. Again, the depth of the confining layer may vary throughout RFI Unit 16 (approximately 30-50 feet), and

TABLE 2-18

RFI UNIT 16
SUBSURFACE SOIL SAMPLING DETAILS
MCAS, CHERRY POINT, NORTH CAROLINA

Soil Boring Number	Sampling Interval (feet)	Sample Type	Analysis
16B01, 16B04 16B09,16B10	0.5-2.5	Split-spoon	TCL Volatiles(4)
	3.0-5.0	Split-spoon	TCL Volatiles(4)
	5.5-7.5(1)	Split-spoon	TCL Volatiles(4)
	8.0-10.0(1)	Split-spoon	TCL Volatiles(4)
	28-30(2)	Split-spoon	None
	33-35(2)	Split-spoon	None
	38-40(2)	Split-spoon	None
16B02, 16B03 16B05,16B06 16B07, 16B08	0.5-2.5	Split-spoon	TCL Volatiles(4)
	3.0-5.0	Split-spoon	TCL Volatiles(4)
	5.5-7.5(1)	Split-spoon	TCL Volatiles(4)
	8.0-10.0(1)	Split-spoon	TCL Volatiles(4)
16GW10, 16GW11, 16GW13, 16GW14, 16GW15	28-30(2)	Split-spoon	None
	33-35(2)	Split-spoon	None
	38-40(2)	Split-spoon	None
16GW12, 16GW16	28-30(2)	Split-spoon	None
	33-35(2)	Split-spoon	None
	38-40(2)	Split-spoon	None
	40-42(3)	Thin-wall tube	Porosity, Permeability

(1) If water table is reached with previous split-spoon sample then this split-spoon sample will not be taken.

(2) Actual sampling interval and number of split-spoon samples will be determined in the field by site geologist.

(3) Actual sampling interval is dependent on depth of confining layer (30-50 feet) and will be determined in the field by the site geologist.

(4) If positive HNu readings occur during inspection of soil borings 16B01-16B10. Soil samples can be obtained from the 10 borings and analyzed for TCL volatile organics. This sampling and analysis is considered optional.

TABLE 2-19

RFI UNIT 16
LABORATORY ANALYSIS OF SUBSURFACE SOIL SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses[b]	Trip Blanks	Field and or Rinsate Blanks	Field Duplicates 1/10	Grand[a] Total
Porosity	---	E	2[1]	---	---	---	2
Permeability	SW9100	E	2[1]	---	---	---	2
TCL Volatiles[a]	CLP	C	[2]	---	---	---	---

(a) TCL - Target Compound List.
(b) Does not include QA/QC samples (see Section 3.2.2).
(1) Monitoring well borings 16GW12 and 16GW16 (one thin-wall tube samples per boring).
(2) Actual number of samples is dependent on the number of positive HNu readings observed during sampling. This analysis is considered optional.

therefore the actual number and depths of the split-spoon samples required to locate the confining layer will be determined in the field by the site geologist. The split-spoon samples will be taken for lithographic description only. No split-spoon samples will be collected for laboratory analysis.

For monitoring well borings 16GW12 and 16GW16, once the confining layer is located, a thin-wall tube sample will be taken from the confining layer and analyzed for porosity and permeability (see Table 2-19).

2.3.3.3 Surface Water Sampling

Surface water samples will be collected from two locations in Slocum Creek and two locations in Sandy Branch as shown in Figure 2-3b. The laboratory analysis program for surface water is summarized in Table 2-20. All four surface water samples will be analyzed for the following parameters:

- TCL volatiles
- Total metals (filtered/unfiltered)
- Total Suspended Solids (TSS)
- Cyanide

In addition to the parameters listed above, two of the four surface water samples will be analyzed for hardness. One of these samples will be collected in Sandy Branch nearest to Slocum Creek and the other from the furthest downgradient location in Slocum Creek (see Figure 2-3b).

2.3.3.4 Sediment Sampling

Sediment samples will be collected from two locations in Slocum Creek and two locations in Sandy Branch as shown in Figure 2-3b. The laboratory analysis program for sediments is summarized in Table 2-21. All four sediment samples will be analyzed for the following parameters:

- TCL volatiles
- Total metals
- Cyanide

In addition to the parameters listed above, two of the four sediment samples will be analyzed for Total Organic Carbon (TOC). One of these samples will be collected in Sandy Branch nearest to

TABLE 2-20

RFI UNIT 16
LABORATORY ANALYSIS OF SURFACE WATER SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses[c]
TCL Volatiles[a]	CLP[b]	C	4
Priority Pollutant Metals (filtered/unfiltered)	(1)	C	8
Cyanide	EPA 335.2	E	4
Hardness	SM 314B	E	2 (2)
Total Suspended Solids (TSS)	EPA 160.2	E	4

(a) TCL = Target Compound List.
(b) CLP = Contract Laboratory Program.
(c) Does not include QA/QC samples (see Section 3.2.2).

(1)

Antimony	CLP 204.2	Mercury	CLP 245.1, CLP 245.5
Arsenic	CLP 206.2	Nickel	CLP 200.7
Beryllium	CLP 200.7	Selenium	CLP 270.2
Cadmium	CLP 200.7	Silver	CLP 272.1
Chromium	CLP 200.7	Thallium	CLP 279.2
Copper	CLP 200.7	Zinc	CLP 200.7
Lead	CLP 239.2		

(2) One sample will be taken in Sandy Branch nearest to Slocum Creek and one sample from Slocum Creek at furthest location downstream (Figure 2-3b).

TABLE 2-21

RFI UNIT 16
LABORATORY ANALYSIS OF SEDIMENT SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses
TCL Volatiles(a)	CLP(b)	C	4
TCL Metals(a)	CLP(b)	C	4
Cyanide	EPA 335.2	C	4
Total Organic Carbon (TOC)	SW 9060	E	2 (1)

(a) TCL = Target Compound List.
(b) CLP = Contract Laboratory Program.
(c) Does not include QA/QC samples (see Section 3.2.2).

(1) One sample will be taken in Sandy Branch nearest to Slocum Creek and one sample from Slocum Creek at furthest location downstream (Figure 2-3b).

Slocum Creek and the other from the furthest downgradient location in Slocum Creek (see Figure 2-3b).

2.4 RFI UNIT 17 FIELD ACTIVITIES

2.4.1 Surveying Operations

The locations of the two new monitoring wells (17GW01 and 17GW02), shown in Figure 2-4, will be surveyed following their installation.

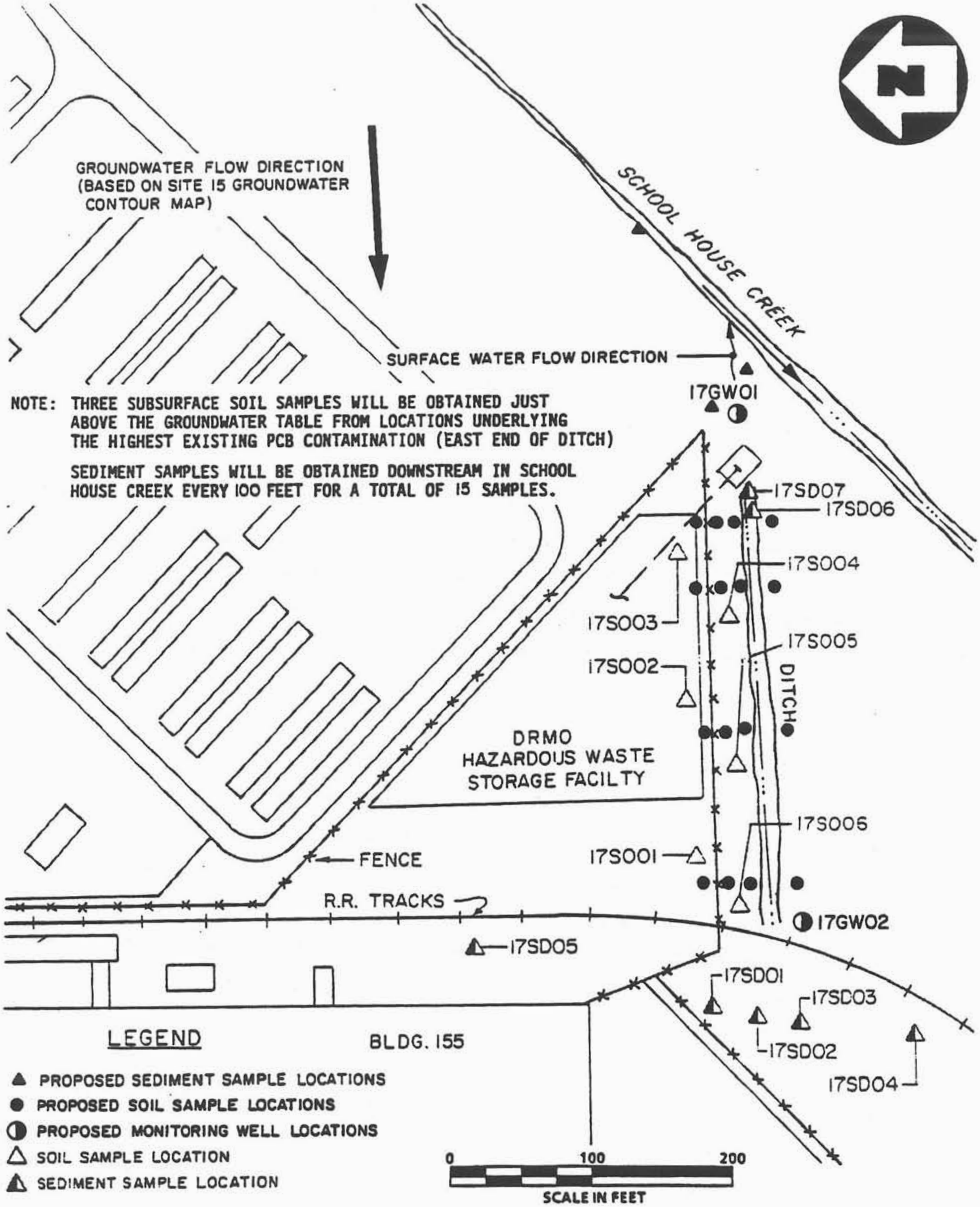
2.4.2 Drilling Operations

2.4.2.1 Monitoring Well Installation and Testing

A total of two new monitoring wells will be installed at RFI Unit 17. The locations of these proposed monitoring wells are shown in Figure 2-4. Additional monitoring well construction/installation procedures are presented in Section 3.3.4. Monitoring well numbers, depths, well screen intervals, and location descriptions are presented in Table 2-22. As shown in Table 2-22, both wells will be installed to a depth of 15 feet. However, in order to locate the depth of the confining layer, both will be drilled to an initial depth of approximately 40 feet and then backfilled with bentonite to the well depth of 15 feet.

In order to locate the depth of the confining layer, split-spoon samples will be taken from the monitoring well borings for lithologic description only. No soil samples will be taken from the monitoring well borings for laboratory analysis. The first split-spoon sample will be taken at approximately 28-30 feet and then at approximately 5-foot intervals. Because the depth of the confining layer may vary throughout RFI Unit 17 (approximately 30-50 feet), the actual number and depths of the split-spoon samples required to locate the confining layer will be determined in the field by the site geologist.

One round of groundwater samples will be collected from the new wells for laboratory analysis as described in Section 2.4.3.1. Well development and aquifer testing (slug tests), will be performed on each new well as described in Sections 3.3.5 and 3.3.6, respectively. One round of synoptic water-level measurements will be obtained from the two new wells, in conjunction with the wells in RFI Units 15 and 16, within a 4-hour period as described in Section 3.3.7 (monitoring wells



SITE 17
PROPOSED SAMPLING LOCATIONS (PHASE I)
AND GROUNDWATER CONTOUR MAP
MCAS CHERRY POINT, NC

FIGURE 2-4

NUS CORPORATION

TABLE 2-22

RFI UNIT 17
MONITORING WELL INSTALLATION DETAILS
MCAS, CHERRY POINT, NORTH CAROLINA

Monitoring Well Number	Total Boring Depth (feet)	Well Depth (feet)	Riser Length (feet)	Screen Length (feet)	Location
17GW01	40 (approximate)(1)	15	7	10	East end of ditch
17GW02	40 (approximate)(1)	15	7	10	West end of ditch

(1) Boring will be drilled to depth of confining layer (approximately 30-50 feet). Boring will be backfilled with bentonite to well depth (15 feet).

in RFI Unit 15 are shown in Figure 2-3c). A second round of water-level measurements will be performed on each new well within a 24-hour period as described in Section 3.3.7. A summary of the monitoring well installation and testing activities for RFI Unit 17 is given below:

- Install 2 monitoring wells (17GW01-17GW02).

- Conduct a slug test on each new well.

- Obtain synoptic water-level measurements from all wells within a 4-hour period (including wells in RFI Units 15 and 16).

- Obtain a second round of water-level measurements from new wells within a 24-hour period.

2.4.3 Media Sampling Operations

The following media will be sampled at RFI Unit 17:

- Groundwater
- Soil
- Sediment

The sample identification system used for the media is presented in Section 3.2.1. Sample handling, packaging and shipping, and documentation are discussed in Sections 3.2.2, 3.2.3, and 3.2.4, respectively. With respect to the quality of data needed to support the RFI and CMS activities, a Data Quality Objective (DQO) Level C will be used for all samples. Protocols for DQO Level C are described in Section 9.0 of the "NUS Corporation Laboratory Quality Assurance Plan in support of the Department of the Navy Requirements for Quality Control of Analytical Data."

2.4.3.1 Groundwater Sampling

One round of groundwater samples will be taken from the two new monitoring wells (17GW01 and 17GW02). Groundwater sampling locations are shown in Figure 2-4. The laboratory analysis of groundwater samples is summarized in Table 2-23. The two monitoring wells will be analyzed for the following parameters:

TABLE 2-23

RFI UNIT 17
LABORATORY ANALYSIS OF GROUNDWATER SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses[b]
PCBs	CLP[a]	C	2
Total Petroleum Hydrocarbons	EPA 418.1	E	2
Total Suspended Solids (TSS)	EPA 160.2	E	2

(a) CLP = Contract Laboratory Program
(b) Does not include laboratory QA/QC samples (see Section 3.2.2).

- PCBs
- Total Petroleum Hydrocarbons
- Total Suspended Solids (TSS)

If a floating product layer is detected in either of the two monitoring wells, samples of the floating product will be collected and analyzed as described in the following section.

2.4.3.2 Floating Product

If a floating product layer is detected in either of the two monitoring wells (17GW01 and 17GW02), a sample of the floating product will be collected from that well and analyzed for the parameters listed in Table 2-24.

2.4.3.3 Soil Sampling

A total of 23 soil samples will be collected from 16 locations within the ditch adjacent to the DRMO Hazardous Waste Storage Facility as shown in Figure 2-4. Details of the soil sampling and analyses for RFI Unit 17 are summarized in Table 2-25. Hand augers and other hand tools will be used to collect the samples as described in Section 3.4.1. The 23 soil samples will be collected at depths ranging from approximately 0-4 feet as follows:

- Sixteen samples just below surface.
- Four samples at a 2-foot depth.
- Three samples just above the water table (approximately 2-4 feet).

All 23 soil samples will be analyzed for the following:

- PCBs
- Total Petroleum Hydrocarbons

The four 2-foot-deep samples will be taken at locations south of the ditch. The three samples taken from just above the water table will be collected from the eastern portion of the ditch in the areas of highest contamination (to be determined in the field).

TABLE 2-24

RFI UNIT 17
LABORATORY ANALYSIS OF FLOATING PRODUCT SAMPLES (OPTIONAL)
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses [b]
PCBs	CLP[a]	C	2[c]
British Thermal Unit (BTU)	ASTM D3286	C	2[c]
Flashpoint	TBD	E	2[c]
Density	TBD	E	2[c]
Viscosity	TBD	E	2[c]

(a) CLP - Contract Laboratory Program.
(b) Does not include QA/QC samples (see Section 3.2.2).
(c) One sample per well will be taken only if floating product is encountered in that well.
PCBs Polychlorinated biphenyls.
TBD To Be Determined.

TABLE 2-25

RFI UNIT 17
LABORATORY ANALYSIS OF SOIL SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses(b)
PCBs	CLP(a)	C	23 (1)
Total Petroleum Hydrocarbons	SW 3550/ EPA 418.1	E	23 (1)
Total Organic Carbon (TOC)	SW9060	E	12 (2)
British Thermal Unit (BTU)	ASTM D3286	E	3 (3)
Grain Size	ASTM D422	E	3 (3)
Density	Agronomy No. 9	E	3 (3)

(a) CLP = Contract Laboratory Program.
(b) Does not include QA/QC samples (see Section 3.2.2).

(1) Samples will be taken from 16 locations as follows:
- 16 samples just below surface.
- 4 samples at a 2-foot depth (see Footnote 2).
- 3 samples just above the water table (see Footnote 3).

(2) Eight samples will be taken at four locations to the south of ditch (Figure 2-4); at each location, one sample will be taken at a 2-foot depth and one sample just below surface. Four samples will be taken at four locations north along ditch (Figure 2-4) at 2-foot depths (one sample per location).

(3) Three samples will taken near old sample location 17S006 (Figure 2-4) (one sample just below surface, one sample at a 2-foot depth, and one sample just above water table).

A total of 12 samples will be analyzed for Total Organic Carbon (TOC) as follows:

- Eight samples from four sample locations south of the ditch (one sample below surface and one sample at a 2-foot depth at each sample location).
- Four samples from four sample locations north along the ditch (one sample at a 2-foot depth at each sample location).

A total of 3 samples will be analyzed for BTU, grain size, and density as follows:

- Three samples from one location near existing sample location 17SD06 (one sample below surface, one sample at a 2-foot depth, and one sample just above the water table).

2.4.3.4 Sediment Sampling

Sediment samples will be collected from 18 locations. Two sediment samples will be taken between the ditch and School House Creek in an area of surface water runoff; 1 sediment sample upstream in School House Creek; and 15 sediment samples downstream in School House Creek at approximately 100-foot intervals. Samples in School House Creek will be taken 2 feet perpendicular to the shoreline. The laboratory analysis program for sediments is summarized in Table 2-26. All 18 sediment samples will be analyzed for the following parameters:

- PCBs
- Total Petroleum Hydrocarbons
- Total Organic Carbon (TOC)

TABLE 2-26

RFI UNIT 17
LABORATORY ANALYSIS OF SEDIMENT SAMPLES
MCAS, CHERRY POINT, NORTH CAROLINA

Parameter	Analytical Method	DQO Level	Total Number of Analyses
PCBs	CLP[(a)]	C	18
Total Petroleum Hydrocarbons	SW 3550/ EPA 418.1	E	18
Total Organic Carbon (TOC)	SW9060	E	18

(a) CLP = Contract Laboratory Program.
(b) Does not include QA/QC samples (see Section 3.2.2).

3.0 SAMPLING PROCEDURES AND FIELD INVESTIGATION OPERATIONS

This section defines and discusses the sampling operations and procedures, including proper documentation, for the proposed RFI field activities. The following items are discussed in this section:

- Documentation of procedures for preparation of reagents or supplies which become an integral part of the sample (e.g., filters, and adsorbing reagents);
- Procedures and forms for recording the exact location and specific considerations associated with sample acquisition;
- Documentation of specific sample preservation methods;
- Calibration documentation of field devices;
- Documentation of collection of replicate samples;
- Submission of field-biased blanks, where appropriate;
- Documentation of potential interferences at the facility;
- Selection and documentation of construction materials and techniques, associated with monitoring wells, piezometers, and drive points;
- Specification of appropriate field equipment;
- Specification of appropriate sampling order;
- Selection of appropriate sample containers;
- Specification of sample preservation;

- Documentation of chain-of-custody, including:

  - Standardized field tracking reporting forms to establish sample custody in the field prior to shipment;

  - Pre-prepared sample labels containing all information necessary for effective sample tracking.

3.1 FIELD INVESTIGATION ACTIVITIES

This RFI field investigation will consist of the following tasks:

- Mobilization/demobilization.
- Drilling operations for soil borings and monitoring wells, and monitoring well installation.
- Subsurface and near-surface soil sampling.
- Groundwater sampling.
- Surface water and sediment sampling.
- Plane table surveying.
- Collection of static water level measurements from monitoring wells.

3.2 GENERAL FIELD GUIDELINES

This section describes the field procedures and quality assurance/quality control (QA/QC) methodologies which will be employed by NUS personnel and subcontractors during the field activities. The EPA Region IV Standard Operating Procedures and Quality Assurance Manual (EPA, April 1986) and the NUS Standard Operating Procedures (NUS, 1989) are used as references for field procedures. The NUS Standard Operating Procedures have been approved by EPA for use under the ARCS Programs and are commonly referenced in this plan because of the similarity to the EPA Region IV protocols. Any inconsistencies between NUS and Region IV protocols have been documented. NUS field personnel are well trained in the use of the NUS procedures; therefore, procedures are anticipated to be consistently implemented during all phases of work by NUS personnel.

3.2.1 Sample Identification System

Each sample collected from the various RFI Units will be assigned a unique sample tracking number. The sample tracking number will consist of a four-segment, alpha-numeric code that identifies the

(1) RFI Unit, (2) sample medium, (3) location, and (4) the sample depth (in the case of soil samples) or the event (in the case of monitoring well groundwater samples). A fifth segment will be added to denote quality assurance samples, when appropriate. Any other pertinent information regarding sample identification will be recorded in the field logbooks.

The alpha-numeric coding to be used in the sample numbering system is explained in the following diagram and the subsequent definitions:

NN	—	AA	—	NNN	—	NNNN	—	A
RFI UNIT		MEDIUM		STATION LOCATION		SAMPLE IDENTIFIER		QA SAMPLE DESIGNATION

Character type:

A = Alpha
N = Numeric

RFI Unit:

The assigned RFI Unit number

Medium:

GW	=	Groundwater from monitoring well
PW	=	Groundwater from potable well
B	=	Subsurface soil sample from soil boring
SO	=	Soil sample from surface or hand auger
SW	=	Surface Water
SD	=	Sediment
FP	=	Floating product from a monitoring well

Station Location:

Sample locations of a given medium will be numbered sequentially beginning with "01" for all media except for monitoring wells. Numbers for new monitoring wells will follow sequentially from the highest number designated for the existing wells.

Sample Identifier:

For soil samples: Interval depth, in feet, of sample.

For groundwater samples, floating product samples: Sample round.

For surface water and sediment samples: This segment will be omitted.

QA Sample Designation:

D = Field Duplicate
F = Field Blank
R = Rinsate Blank
T = Trip Blank
Omitted for other samples.

For example, a groundwater sample collected during Round 2 from Monitoring Well 5GW08 at RFI Unit 5 would be designated as:

05-GW-08-02

A subsurface soil sample collected from Soil Boring 5B03 at RFI Unit 5 from 1 to 1.5 feet below the ground surface would be designated as:

05-B-03-0101.5

A duplicate sample from this soil sample would be:

05-B-03-0101.5-D

3.2.2 Sample Handling and QA/QC Samples

Sample handling includes the field-related considerations connected with the selection of sample containers, preservatives, allowable holding times, and the analyses requested. The EPA Region IV Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual, Appendix A, addresses the topics of containers and sample preservation. Table 3-1 provides a unit-specific summary of all sample handling considerations. The combined QA/QC samples for RFI Units 5,

R3389010

TABLE 3-1

SUMMARY OF ANALYSES, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
MCAS, CHERRY POINT, NORTH CAROLINA

Media	Analysis	Number of Samples[(a)]	Number of Containers per Sample	Type of Container	Preservation Requirements	Holding Time
RFI UNIT 5						
Groundwater	TCL Volatiles	10	3	40-mL VOA vials	HCl to pH <2 Cool to 4°C	14 days to analysis
	PCBs	10	2	1-Liter amber bottles	Cool to 4°C	7 days to extraction; 40 days to analysis
	Total Suspended Solids	10	1	500-mL polyethylene bottle	Cool to 4°C	7 days
	Total Organic Carbon (TOC)	5	1	500-mL polyethylene bottle	HCl to pH <2 Cool to 4°C	28 days
	Total Petroleum Hydrocarbons	10	1	1-quart wide-mouth glass jar	HCl to pH <2 Cool to 4°C	28 days
Subsurface Soil	TCL Volatiles	47	4	40-mL VOA vials	Cool to 4°C	10 days to analysis
	TCL BNAs, pesticides/PCBs	28	1	8-ounce wide-mouth glass jar	Cool to 4°C	7 days to extraction; 40 days to analysis
	PCBs	19	1	8-ounce wide-mouth glass jar	Cool to 4°C	7 days to extraction; 40 days to analysis
	TCL Metals	28	1	8-ounce wide-mouth glass jar	Cool to 4°C	6 months; Hg-28 days
	Total Organic Carbon	8	1	8-ounce wide-mouth glass jar	Cool to 4°C	28 days
	Density	4	1	32-ounce wide-mouth glass jar	None	7 days
	Grain size	4	1	32-ounce wide-mouth glass jar	None	7 days
	British Thermal Units	4	1	4-ounce wide-mouth glass jar	None	7 days
	Total Petroleum Hydrocarbons	47	1	8-ounce wide-mouth glass jar	None	28 days
Sediments	PCBs	6	1	8-ounce wide-mouth glass jar	Cool to 4°C	7 days to extraction; 40 days to analysis
	Total Organic Carbon	6	1	8-ounce wide-mouth glass jar	Cool to 4°C	28 days
Floating Product[(b)] (Optional)	PCBs	TBD	1	8-ounce wide-mouth glass jar (metal paint can)	None	7 days to extraction 40 days to analysis
	BTU, Flash point, viscosity	TBD	1	8-ounce wide-mouth glass jar	None	7 days
	Density	TBD	1	32-ounce wide-mouth glass jar	None	7 days

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R3389010

TABLE 3-1
SUMMARY OF ANALYSES, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
MCAS, CHERRY POINT, NORTH CAROLINA
PAGE TWO

Media	Analysis	Number of Samples[a]	Number of Containers per Sample	Type of Container	Preservation Requirements	Holding Time
RFI UNIT 10						
Groundwater	TCL Volatiles	35	3	40-mL VOA vials	HCl to pH <2 Cool to 4°C	14 days to analysis
	Priority Pollutant Metals (filtered)	35	1	1-Liter polyethylene bottle	HNO_3 to pH < 2 Cool to 4°C	6 months; Hg-28 days
	Priority Pollutant Metals (unfiltered)	35	1	1-Liter polyethylene bottle	HNO_3 to pH <2 Cool to 4°C	6 months; Hg-28 days
	Total Organic Carbon (TOC)	20	1	500-mL polyethylene bottle	HCl to pH <2 Cool to 4°C	28 days
	TCL BNA/pesticides/PCBs	2	2	80-ounce amber glass bottle	Cool to 4°C	7 days to extraction; 40 days to analysis
	Total Suspended Solids	35	1	500-mL polyethylene bottle	Cool to 4°C	7 days
	Biochemical Oxygen Demand (BOD_5)	20	1	1-Liter amber glass bottle	Cool to 4°C	48 hours
Subsurface Soil	TCL Volatiles	6	4	40-mL VOA vials	Cool to 4°C	10 days to analysis
	TCL Metals	6	1	8-ounce wide-mouth glass jar	Cool to 4°C	6 months; Hg-28 days
	TCL BNA/pesticides/PCBs	2	1	8-ounce wide-mouth glass jar	Cool to 4°C	7 days to extraction; 40 days to analysis
	Total Organic Carbon	6	1	8-ounce wide-mouth glass jar	Cool to 4°C	28 days
	Cation Exchange Capacity (CEC)	2	1	4-ounce wide-mouth glass jar	None	7 days
	British Thermal Units	2	1	4-ounce wide-mouth glass jar	None	7 days
	Porosity, Permeability	2	1	Shelby tube	None	None

R3389010

TABLE 3-1
SUMMARY OF ANALYSES, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
MCAS, CHERRY POINT, NORTH CAROLINA
PAGE THREE

Media	Analysis	Number of Samples[(a)]	Number of Containers per Sample	Type of Container	Preservation Requirements	Holding Time
RFI UNIT 10 (Continued)						
Surface Water	TCL Volatiles	6	3	40-mL VOA vials	HCl to pH <2 Cool to 4°C	14 days to analysis
	Priority Pollutant Metals (filtered)	6	1	1-Liter polyethylene bottle	HNO_3 to pH < 2 Cool to 4°C	6 months; Hg-28 days
	Priority Pollutant Metals (unfiltered)	6	1	1-Liter polyethylene bottle	HNO_3 to pH <2 Cool to 4°C	6 months; Hg-28 days
	Total Suspended Solids	6	1	500-mL polyethylene bottle	Cool to 4°C	7 days
	Hardness	2	1	500-mL polyethylene bottle	Cool to 4°C	14 days
Sediment	TCL Volatiles	6	4	40-mL VOA vials	Cool to 4°C	10 days analysis
	TCL Metals	6	1	8-ounce wide-mouth glass jar	Cool to 4°C	6 months; Hg-28 days
	Total Organic Carbon	6	1	8-ounce wide-mouth glass jar	Cool to 4°C	28 days
RFI UNIT 16						
Groundwater	TCL Volatiles	18	3	40-mL VOA vials	HCl to pH <2 Cool to 4°C	14 days to analysis
	Priority Pollutant Metals (filtered)	18	1	1-Liter polyethylene bottle	HNO_3 to pH < 2 Cool to 4°C	6 months; Hg-28 days
	Priority Pollutant Metals (unfiltered)	18	1	1-Liter polyethylene bottle	HNO_3 to pH < 2 Cool to 4°C	6 months; Hg-28 days
	Cyanide	18	1	1-Liter polyethylene bottle	NaOH to pH >12 0.6 g ascorbic acid Cool to 4°C	14 days
	Total Organic Carbon	10	1	500-mL polyethylene bottle	HCl to pH <2 Cool to 4°C	28 days
	Total Suspended Solids	18	1	500-mL polyethylene bottle	Cool to 4°C	7 days
	Biochemical Oxygen Demand (BOD_5)	10	1	1-Liter amber glass bottle	Cool to 4°C	48 hours

TABLE 3-1
SUMMARY OF ANALYSES, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
MCAS, CHERRY POINT, NORTH CAROLINA
PAGE FOUR

Media	Analysis	Number of Samples(a)	Number of Containers per Sample	Type of Container	Preservation Requirements	Holding Time
RFI UNIT 16 (Continued)						
Surface Water	TCL Volatiles	4	3	40-mL VOA vials	HCl to pH >2 Cool to 4°C	14 days to analysis
	Priority Pollutant Metals (filtered)	4	1	1-Liter polyethylene bottle	HNO_3 to pH <2 Cool to 4°C	6 months; Hg-28 days
	Priority Pollutant Metals (unfiltered)	4	1	1-Liter polyethylene bottle	HNO_3 to pH <2 Cool to 4°C	6 months; Hg-28 days
	Cyanide	4	1	1-Liter polyethylene bottle	NaOH to pH >12 0.6 g ascorbic acid Cool to 4°C	14 days
	Hardness	2	1	500-mL polyethylene bottle	Cool to 4°C	14 days
	Total Suspended Solids	4	1	500-mL polyethylene bottle	Cool to 4°C	7 days
Sediment	TCL Volatiles	4	4	40-mL VOA vials	Cool to 4°C	10 days to analysis
	TCL Metals and Cyanide	4	1	8-ounce wide-mouth glass jar	Cool to 4°C	6 months; Hg-28 days; CN-14 days
	Total Organic Carbon (TOC)	2	1	8-ounce wide-mouth glass jar	Cool to 4°C	28 days
Subsurface Soil	Porosity, Permeability	2	1	Shelby tube	None	None
	TCL Volatiles (Otional)	(1)	4	40-ml VOA vials	Cool to 4°C	10 days to analysis

TABLE 3-1
SUMMARY OF ANALYSES, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
MCAS, CHERRY POINT, NORTH CAROLINA
PAGE FIVE

Media	Analysis	Number of Samples[a]	Number of Containers per Sample	Type of Container	Preservation Requirements	Holding Time
RFI UNIT 17						
Groundwater	PCBs	2	2	1-Liter amber glass bottle	Cool to 4°C	7 days to extraction; 40 days to analysis
	Total Petroleum Hydrocarbons	2	1	1-quart wide-mouth glass jar	HCl to pH <2 Cool to 4°C	28 days
	Total Suspended Solids	2	1	500-mL polyethylene bottle	Cool to 4°C	7 days
Soil	PCBs	23	1	8-ounce wide-mouth glass jar	Cool to 4°C	7 days to extraction; 40 days to analysis
	Total Petroleum Hydrocarbons	23	1	8-ounce wide-mouth glass jar	None	28 days
	Total Organic Carbon (TOC)	12	1	8-ounce wide-mouth glass jar	Cool to 4°C	28 days
	British Thermal Units	3	1	4-ounce wide-mouth glass jar	None	7 days
	Grain size	3	1	32-ounce wide-mouth glass jar	None	7 days
	Density	3	1	32-ounce wide-mouth glass jar	None	7 days
Sediment	PCBs	18	1	8-ounce wide-mouth glass jar	Cool to 4°C	7 days to extraction; 40 days to analysis
	Total Petroleum Hydrocarbons	18	1	8-ounce wide-mouth glass jar	None	28 days
	Total Organic Carbon (TOC)	18	1	8-ounce wide-mouth glass jar	Cool to 4°C	28 days
Floating Product[b] (Optional)	PCBs	TBD	1	8-ounce wide-mouth glass jar (metal paint can)	None	7 days to extraction; 40 days to analysis
	BTU, Flash point viscosity	TBD	1	8-ounce wide-mouth glass jar	None	7 days
	Density	TBD	1	32-ounce wide-mouth glass jar	None	7 days

(1) Actual number of samples is dependent on the number of positive HNu readings observed during sampling.
(a) Does not include QA/QC samples (see Table 3-2).
(b) One sample per well will be taken only if floating product is encountered in that well.
TBD To Be Determined.

10, 16, and 17 are specified in Table 3-2 for each media along with their sample handling considerations. Definitions of the four types of QA/QC samples are given below.

Field Duplicate - A single sample split into two portions, each of which is submitted blindly to the laboratory. Assesses the overall precision of sampling and analysis program (also known as a Replicate Sample). The number of field duplicates to be collected is shown in Table 3-2. These samples will be collected at a rate of approximately1 sample per every 10 samples per medium.

Rinsate Blanks - Samples generated from the sampling equipment in use. Equipment is tested for carryover contamination before use and between subsequent uses by collecting a rinsate sample. The number of rinsate blanks to be collected is shown in Table 3-2. These samples will be collected at a rate of approximately 1/day/medium.

Field Blanks - Samples consisting of the source water used in decontamination and steam cleaning. The number of field blanks to be collected is shown in Table 3-2. These samples will be collected at the rate of approximately 1/event/media.

Trip Blanks - Allow the evaluation of contamination generated from sample containers and changes occurring during the shipping process. Samples are prepared prior to the sampling trip. Trip blanks are not exposed to field conditions. These are typically associated with the analysis of volatile organic compounds.

3.2.3 Sample Packaging and Shipping

Samples will be packaged and shipped in accordance with Appendix C of the the EPA (Region IV) Standard Operating Procedures and Quality Assurance Manual. The field operations leader will be responsible for contacting the laboratory for notification of shipment and will report the following:

- Site name/code;
- Number(s), matrix(ces), and concentration(s) of samples shipped;
- Method of shipment (e.g., overnight, 2-day);
- Date of shipment;
- Suspected hazards associated with the samples or site.

R3389010

TABLE 3-2

**SUMMARY OF QA/QC SAMPLES, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
MCAS, CHERRY POINT, NORTH CAROLINA**

Analysis	Field Duplicates	Trip Blanks	Field Blanks	Rinsate Blanks	Number of Containers per Sample	Type of Container	Preservation Requirements	Holding Time
GROUNDWATER								
TCL Volatiles	7	2	1	3	3	40-mL VOA vials	HCl to pH <2 Cool to 4°C	14 days to analysis
Priority Pollutant Metals (filtered)	6	-	1	2	1	1-Liter polyethylene bottle	HNO_3 to pH <2 Cool to 4°C	6 months; Hg-28 days
Priority Pollutant Metals (unfiltered)	6	-	1	2	1	1-Liter polyethylene bottle	HNO_3 to pH <2 Cool to 4°C	6 months; Hg-28 days
Cyanide	2	-	1	1	1	1-Liter polyethylene bottle	NaOH to pH >12 0.6 g ascorbic acid Cool to 4°C	14 days
TCL BNA/Pesticides/PCBs	1	-	1	1	2	80-ounce amber glass bottle	Cool to 4°C	7 days to extraction; 40 days to analysis
Total Petroleum Hydrocarbons	1	-	1	1	1	1-quart wide-mouth glass jar	HCl to pH <2 Cool to 4°C	28 days
Total Organic Carbon (TOC)	4	-	1	2	1	500-ml polyethylene bottle	HCl to pH <2 Cool to 4°C	28 days
Total Suspended Solids	7	-	1	3	1	500-ml polyethylene bottle	Cool to 4°C	7 days
Biochemical Oxygen Demand (BODs)	3	-	1	2	1	1-liter amber glass bottle	Cool to 4°C	48 hours
PCBs	1	-	1	1	2	1-liter amber glass bottle	Cool to 4°C	7 days to extraction; 40 days to analysis

CP-00402-3.05-10/1/90

TABLE 3-2
SUMMARY OF QA/QC SAMPLES, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
MCAS, CHERRY POINT, NORTH CAROLINA
PAGE TWO

Analysis	Field Duplicates	Trip Blanks	Field Blanks	Rinsate Blanks	Number of Containers per Sample	Type of Container	Preservation Requirements	Holding Time
SUBSURFACE SOIL								
TCL Volatiles	6	2	1	3	4	40-mL VOA vials	Cool to 4°C	10 days to analysis
TCL Metals	4	1	1	3	1	8-ounce wide-mouth glass jar	Cool to 4°C	6 months; Hg-28 days
TCL BNA/Pesticides/PCBs	4	1	1	3	1	8-ounce wide-mouth glass jar	Cool to 4°C	7 days to extraction 40 days to analysis
PCBs	2	-	-	1	1	8-ounce wide-mouth glass jar	Cool to 4°C	7 days to extraction 40 days to analysis
Total Organic Carbon (TOC)	2	-	1	1	1	8-ounce wide-mouth glass jar	Cool to 4°C	28 days
Density	-	-	-	-	-	-	-	-
Grain Size	-	-	-	-	-	-	-	-
British Thermal Units	1	-	-	-	1	4-ounce wide-mouth glass jar	None	7 days
Total Petroleum Hydrocarbons	5	-	1	2	1	8-ounce wide-mouth glass jar	None	28 days
Cation Exchange Capacity	1	-	1	1	1	4-ounce wide-mouth glass jar	None	7 days
Porosity, Permeability	-	-	-	-	-	-	-	-
SOIL								
PCBs	2	-	-	1	1	8-ounce wide-mouth glass jar	Cool to 4°C	7 days to extraction 40 days to analysis
Total Petroleum Hydrocarbons	2	-	-	1	1	8-ounce wide-mouth glass jar	None	28 days
Total Organic Carbon	1	-	-	1	1	8-ounce wide-mouth glass jar	Cool to 4°C	28 days
British Thermal Units	1	-	-	-	1	4-ounce wide-mouth glass jar	None	7 days
Grain Size	-	-	-	-	-	-	-	-
Density	-	-	-	-	-	-	-	-

R3389010

TABLE 3-2
SUMMARY OF QA/QC SAMPLES, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
MCAS, CHERRY POINT, NORTH CAROLINA
PAGE THREE

Analysis	Field Duplicates	Trip Blanks	Field Blanks	Rinsate Blanks	Number of Containers per Sample	Type of Container	Preservation Requirements	Holding Time
SURFACE WATER								
TCL Volatiles	1	1	-	-	3	40-mL VOA vials	HCl to pH <2 Cool to 4°C	14 days to analysis
Priority Pollutant Metals (filtered)	1	-	-	-	1	1-Liter polyethylene bottle	HNO_3 to pH <2 Cool to 4°C	6 months; Hg-28 days
Priority Pollutant Metals (unfiltered)	1	-	-	-	1	1-Liter polyethylene bottle	HNO_3 to pH <2 Cool to 4°C	6 months; Hg-28 days
Cyanide	1	-	-	-	1	1-Liter polyethylene bottle	NaOH to pH >12 0.6 g ascorbic acid Cool to 4°C	14 days
Total Suspended Solids	1	-	-	-	1	500-mL polyethylene bottle	Cool to 4°C	7 days
Hardness	1	-	-	-	1	500-mL polyethylene bottle	Cool to 4°C	14 days
SEDIMENT								
TCL Volatiles	1	1	-	1	4	40-mL VOA vials	Cool to 4°C	10 days to analysis
TCL Metals and Cyanide	1	-	-	1	1	8-ounce wide-mouth glass jar	Cool to 4°C	6 months; Hg-28 days CN-14 days
PCBs	3	-	-	1	1	8-ounce wide-mouth glass jar	Cool to 4°C	7 days to extraction; 40 days to analysis
Total Organic Carbon	3	-	-	1	1	8-ounce wide-mouth glass jar	Cool to 4°C	28 days
Total Petroleum Hydrocarbons	2	-	-	1	1	8-ounce wide-mouth glass jar	None	28 days
FLOATING PRODUCT								
PCBs	1	-	-	1	1	8-ounce wide-mouth glass jar (metal paint can)	None	7 days to extraction; 40 days to analysis
British Thermal Units	1	-	-	-	1	8-ounce wide-mouth glass jar	None	7 days
Flash Point	-	-	-	-	-	8-ounce wide-mouth glass jar	-	-
Density	-	-	-	-	-	8-ounce wide-mouth glass jar	-	-
Viscosity	-	-	-	-	-	8-ounce wide-mouth glass jar	-	-

3.2.4 Documentation

Custody of samples will be maintained and documented at all times. Chain-of-custody begins with the collection of the samples in the field. A sample is in custody if:

- It is in the field investigator's or the transferee's actual possession;
- It is in the field investigator's or the transferee's view, after being in his/her physical possession;
- It was in the field investigator's or the transferee's physical possession and then he/she secured it to prevent tampering;
- It is placed in a designated secure area.

A chain-of-custody record form shall be used to record the custody of all samples collected and maintained by NUS personnel. The chain-of-custody (COC) also serves as a sample logging mechanism for the laboratory. Section 5.3 of NUS SOP SA-6.1 (See Appendix A) provides a description of the COC procedures that will be followed. An example of the COC record form is included in Appendix B of this plan.

The following is a discussion of the documentation necessary for tracking samples from collection to receipt of the analytical data.

Sample Labels

One label will be filled out for each sample container sent for laboratory analysis. The sample label is a 2-inch by 4-inch white label with black lettering and an adhesive backing. These labels are required on every sample. The sample label description and procedures for completion are found in NUS SOP SA-6.1 Section 5.2 (see Appendix A).

Chain-of-Custody Record

The Chain-of-Custody Record Form accompanies a sample (or group of samples) as it is transferred from person to person. This form must be used for any sample collected for chemical or geotechnical analysis, whether onsite or offsite. An example of the Chain-of-Custody Record Form is included in

Appendix B. Procedures for using this form are contained in SOP SA-6.1 (see Appendix A). At the completion of field activities the Chain-of-Custody Record Form will be placed in the project file.

Custody Seal

The Custody Seal is a 1-inch by 3-inch adhesive backed label. It is part of a Chain-of-Custody process and is used to prevent tampering with samples after they have been collected in the field. It is used whenever samples are shipped with an accompanying Chain-of-Custody Record Form. Procedures for using Chain-of-Custody seals are described in SOP SA-6.1 (see Appendix A).

Sample Logsheet and Logbook

A sample logsheet will be filled out for each sample. A sample logsheet is a notebook (3-ring binder) page that is used to record specified types of data pertaining to the samples. The data recorded on these sheets are useful in describing the sample as well as pointing out any problems encountered during sampling. Data such as container source and description, sample description type, and disposition, as well as time, date and sample method are recorded on this form. Appendix B contains an example of a sample logsheet for various sample media. The sample logbook is a 3-ring binder which contains sample logsheets for each sample collected. The sample logsheets are sequentially numbered when placed in the sample logbook, and the sample number and logsheet page numbers are recorded in the sample logbook table of contents (placed at the front of the logbook) for easy reference and access. At the completion of field activities the sample logbook containing all sample logsheets will be placed in the project file.

Equipment Calibration Log Form

Each NUS field instrument requiring calibration will have a separate equipment calibration log form (see Appendix B) which documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. The information placed on the form documents the accuracy, precision or sensitivity of the measurement, and, if necessary, will be used to determine if correction should be applied to the readings. A separate form will be established and maintained for the following field instruments:

- HNU or OVA
- pH meter
- Specific Conductivity meter

- Electronic water level indicator
- Dissolved oxygen meter

These forms will be maintained in a 3-ring notebook. At the completion of field activities the notebook containing the equipment calibration log forms will be placed in the project file.

3.2.5 Field Changes

Changes in project procedures may be necessary as a result of altered field conditions or unanticipated events. A summary of the sequence of events associated with field changes is as follows:

- The Field Operations Leader (FOL) notifies the NUS Project Manager (PM) of the need for the change.

- If necessary, the NUS PM will discuss the change with the pertinent individuals (e.g., NUS Senior Technical Advisors, NUS Contracting Officer, Remedial Project Manager, and Cherry Point Project Coordinator) and will provide a verbal approval or denial to the FOL for the proposed change.

- The FOL will document the change on a Task Modification Request Form (see Appendix B) and forward the form to the NUS PM immediately.

- The NUS PM will sign the form and distribute copies to the NUS Contracting Officer, NUS Quality Assurance Officer, Remedial Project Manager, Cherry Point Project Coordinator, the NUS FOL, and the Project File.

- A copy of the completed Task Modification Request Form will also be attached to the field copy of the affected document (i.e., RFI Work Plan).

3.2.6 Onsite Project Administration

All onsite project administration activities are the responsibility of the NUS FOL. NUS field personnel will assist the FOL, as needed, in the day-to-day execution of these activities which include the following:

- Track, review, and approve (as needed) subcontractor submittals and payment requests.
- Maintain daily activities record forms.
- Maintain site logbook, field notebooks, and other field records.

Descriptions of the above activities are provided in the following sections.

Subcontractor Submittals

The NUS Project Manager or designee shall be responsible for tracking, reviewing, and approving subcontractor submittals such as requests for payment, boring logs, and well construction forms.

Daily Activities Record Form

The daily activities record is designed for tracking the schedule and budget and progress reporting. This record documents the pay items involved with the daily activities and progress for each Subcontractor. These sheets summarize the work performed and form the basis of payment to the subcontractors. Thus, this information is used to check the subcontractor request for payment. A copy of the daily activities record is included in Appendix B.

Each field team leader who is supervising a subcontractor activity must complete a Daily Activities Record Form. The subcontractor's signature is required at the end of each working day to verify work accomplished and the various pay items (e.g., hours worked, standby time, and material used).

Site Logbook

A site logbook will be maintained by the NUS FOL and/or designee. This book will serve to record all major on site activities during the RFI. The logbook is a bound notebook with consecutively number pages that cannot be removed. It will contain a summary of the day's activities and will reference the other controlled documents (field notebooks, sampling logsheets, chain-of-custody form numbers, calibration logsheets, etc.) when applicable.

The site logbook is initiated at the start of the first onsite activity (e.g., initial reconnaissance survey). Entries are made for every day that onsite activities take place.

The NUS site logbook is issued by the PM (or designee) to the FOL for the duration of the project. It is the responsibility of the FOL to keep the site logbook current throughout the project.

The cover of the site logbook contains the following information:

- Project Name and MCAS, Cherry Point Work Assignment Number
- NUS Project Number
- Field Operation Leader's Name
- Sequential Book Number
- Start Date
- End Date

Daily entries into the logbook may contain a variety of information. At the beginning of each day, the following information must be recorded:

- Date
- Start time
- Weather
- All field personnel present
- Any visitors present

During the day, a summary of all site activities and level of personal protection shall be recorded in the logbook. The information need not duplicate that recorded in other field notebooks (e.g., sample logbook, Site Administrative Officer's notebook, Health and Safety Officer's notebook, etc.), but shall summarize the contents of these other notebooks and refer to the page locations in these notebooks for detailed information.

The sample logsheet for each sample collected (see example forms in Appendix B) must be referenced. If measurements are made at any location, the measurements and equipment used must either be recorded in the site logbook or reference must be made to the notebook and page number(s) on which they are recorded.

All entries shall be made in black pen. No erasures are permitted. If an incorrect entry is made, the data shall be crossed out with a single strike mark, initialed, and dated. At the completion of entries by any individual, the logbook must be signed. It must also be signed by the FOL at the end of each day. Figure 3-1 provides an example of a typical site logbook entry.

Field Notebook

A bound, weatherproof field notebook (daily diary) will be maintained by each NUS representative as designated by the NUS FOL. The field notebook will serve to record the daily activities during the facility investigation. At a minimum, the following NUS field personnel will be responsible for maintaining a personal field notebook (daily diary):

- Field Operations Leader
- Health and Safety Site Officer
- Sampling Leader
- Site Geologist

These NUS representatives shall record daily the appropriate information related to field activities. All entries shall be made in black ink. This information may include, but, not be limited to the following:

- Front cover of field notebook will contain:
  - Project name and MCAS, Cherry Point assignment number.
  - NUS project number.
  - "Field Notebook" descriptor and sequential book number.

- First page will contain:
  - Name of person(s) responsible for maintaining the book, including start and end date.
  - Address and phone number of NUS Pittsburgh office for each person.

- Table of contents referencing page numbers relevant to daily entries

- Daily chronological synopsis of observations, activities, and accomplishments concerning the project, including work performed by the subcontractors and names of people involved, level of Health and Safety, etc.

FIGURE 3-1

TYPICAL SITE LOGBOOK ENTRY
MCAS, CHERRY POINT, NORTH CAROLINA

SITE NAME: ____________________

START TIME: ________________________ DATE: ____________________

FIELD OPERATIONS LEADER: ____

NUS	CONTRACTOR	NAVY/EPA
______________	______________	______________
______________	______________	______________
______________	______________	______________

WEATHER: Clear, 68° F, 2-5 mph wind from SE

ACTIVITIES:

1. ____________ calibrated HNu Number N-1640. See Notebook No. 3, page 10, and *Calibration Log*, page 2 for details.

2. Asbestos removal activities at building _____ resumes. ____________________ observed removal activities. See Notebook No. 1, page 29-20, for details. Sample No. 123-21-S4 collected; see Logbook No. 1, page 31. Removal activities completed at 11:50. See Notebook No. 1, page 31.

3. Tanker truck PF-123 steam-cleaned at decontamination pit. Then set up at tank _______ for ____________________ waste removal. Activities observed by _______________. See Notebook No. 2, page 39 for details.

4. Navy project manager arrives on site at 14:25 hours.

5. Large dump truck 129-FA arrives at 14:45 and is steam-cleaned. Backhoe and dump truck set up at building _____. Begin filling truck with scrap metal. _______________ observed removal activities. See Notebook No. 1, page 32 for details.

6. Express carrier picked up samples (see Logbook No. 2, pages 42 through 45) at 17:50 hours. Site activities terminated at 18:22 hours. All personnel offsite, gate locked.

______________________________ ____________________
FIELD OPERATIONS LEADER OR DESIGNEE DATE

- Sampling activities, including time, location, identification number, sampler's name, reference to sample logsheet, etc.

- Sample pickup (chain-of-custody form numbers, sample numbers, carrier, airbill numbers, time).

- Unusual events, nonconformances, problems, etc., should be described in detail.

- Equipment calibration information including time, equipment type and serial numbers, reference to calibration logsheet, and name of person performing calibration.

- Description of photographs including direction of view, roll number, photo number, special lenses, etc. This can be placed in a separate section of the book (i.e., reserve the last 10 to 20 pages for all photographs).

- Arrival/departure of equipment.

- Signature of unspecified person(s) making entries (at the end of each entry) and signature at the bottom of each page of person responsible for maintaining the notebook. Each field notebook is initiated at the start of the first onsite activity of the person responsible for maintaining it.

Entries are made for every day that onsite activities take place which involve the person responsible for maintaining the book, as assigned or as designated by the NUS PM. No erasures are permitted. If an incorrect entry is made, the data shall be crossed out with a single strike mark, and initialed and dated. Any blank page or blank portions of pages shall also be crossed out, initialed, and dated. It is the responsibility of this person (or designee) to keep the field notebook current while in his possession, and return it to the FOL or to relinquish it to another NUS representative, who signs and dates the inside cover, thus assuming responsibility of it.

NUS Sampling Documentation

Sampling documentation will include, but not be limited to the following:

- Chain-of-custody form
- Sample logsheets and logbook
- Equipment calibration logsheet

At the completion of field activities, the FOL shall submit to the NUS Project Manager all field records, data, field notebooks, logbooks, chain-of-custody receipts, sample log sheets, drilling logs, daily logs, etc. The NUS Project Manager shall ensure that these materials are entered into the document control system in accordance with appropriate administrative guidelines.

3.3 GENERAL FIELD OPERATIONS

3.3.1 Mobilization/Demobilization

Following approval of this Work Plan, NUS will prepare drilling specifications, obtain a drilling subcontractor, and begin mobilization activities. All field team members will review the Work Plan, including the Health and Safety Plan (HASP) which is included as Appendix B of this document. In addition, a field team orientation meeting will be held to familiarize personnel with the scope of the RFI field activities.

Equipment mobilization may include, but will not be limited to, the mobilization and set-up of the following equipment:

- Sampling equipment.
- Hydrogeologic monitoring equipment.
- Health, safety, and decontamination equipment.
- Subcontractor equipment.
- Survey equipment.

The Field Operations Leader (FOL) will coordinate the mobilization activities necessary upon arrival at the facility. The FOL will also make any necessary equipment purchases in order to conduct the field investigation. The equipment required for the RFI field activities will be loaded in Pittsburgh and driven to the site by the FOL and a technician. After field activities are completed, the FOL will demobilize the equipment and drive back to Pittsburgh.

The subcontractor who is awarded the contract to perform the drilling will begin to mobilize equipment immediately after receiving notice to proceed. The subcontractor will be responsible for mobilizing and demobilizing the necessary equipment in order to perform the work outlined in the bid specifications. The subcontractor specification(s) will be prepared following acceptance of the Final Work Plan by the MCAS and EPA.

3.3.2 Drilling Operations

The proposed locations for soil borings and monitoring wells as discussed in Section 2, were selected based on the suspected source areas, the overall expected groundwater flow pattern for the area and the data requirements of the RFI.

3.3.3 Overburden Drilling Procedures

Drilling operations for overburden soil borings will be conducted using any combination of drilling methods needed to drill through the sediments, with the only restriction being that potable water is the only fluid allowed if one is required. The preferred method of drilling is the hollow-stem auger method. The borings shall be advanced in accordance with the drilling specifications developed for this project.

Boring depths for the proposed soil borings are presented in Tables 2-1, 2-8, and 2-15 for RFI Units 5, 10, and 16, respectively. Boring depths for the proposed monitoring wells are presented in Tables 2-2, 2-9, 2-16 and 2-22 for RFI Units 5, 10, 16, and 17, respectively. For borings which penetrate the saturated portion of the water table aquifer, the depth of the water table will be measured and/or confirmed by the field geologist prior to termination of the borehole drilling.

During drilling operations of overburden material, standard penetration tests and split-spoon sampling shall be performed. Split-spoon sampling intervals are presented in Tables 2-5, 2-11, and 2-18 for RFI Units 5, 10, and 16, respectively. These sampling procedures shall be performed in accordance with ASTM D1586-84 (Section 7, see Appendix A) for each soil boring. In addition to any samples sent for laboratory analysis (see Sections 2.1, 2.2, 2.3 and 2.4), all split-spoon soil samples will be analyzed for lithologic description in the field. Field descriptions will be in accordance with NUS SOP GH-1.5: Sections 5.2, 5.4, and 5.5 (See Appendix A).

Each soil sample collected for lithologic description will be placed in an 8-ounce jar (to be provided by the drilling subcontractor), labeled, and the pertinent data recorded (i.e., project, boring and sample numbers, depth, blow counts, and date) by the field geologist. The driller shall prepare a separate written boring log for each boring drilled, to be submitted to the field geologist at the conclusion of the field activities.

A complete log of each well boring will be maintained by NUS in accordance with NUS SOP GH-1.5, Section 5.5. Appendix A contains an example of the boring log description form. At a minimum the boring log will contain the following information, when applicable, for each overburden well boring:

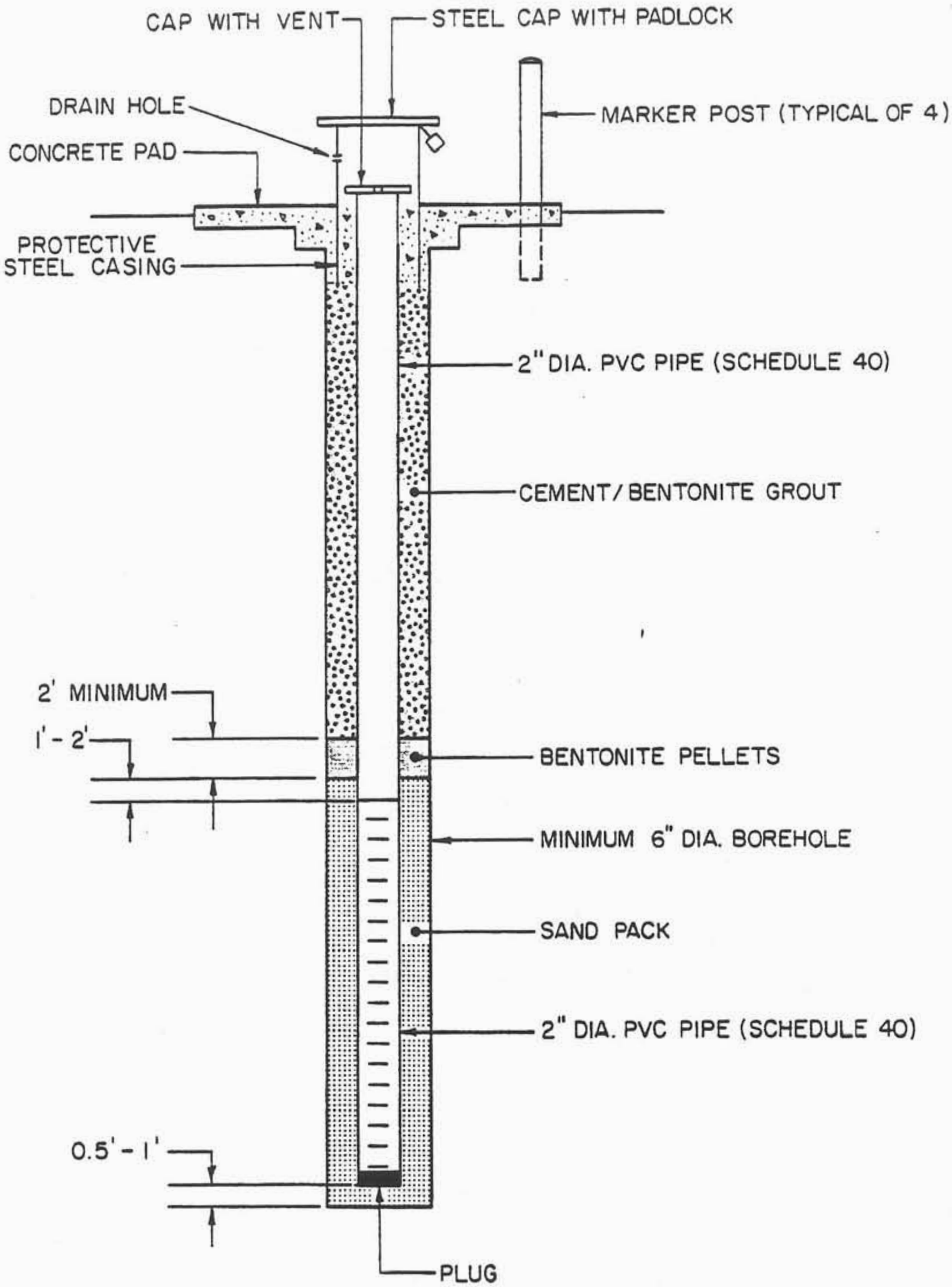
- Sample numbers and types
- Sample depths
- Standard Penetration Test data
- Sample recovery/sample interval
- Soil density or cohesiveness
- Soil color
- Universal Soil Classification System (USCS) material description and symbol

In addition, depths of changes in lithology, sample moisture observations, depth to water, OVA/HNU readings (if taken), drilling methods, and total depth of each borehole should be included on each log, as well as any other pertinent observations. Sample bottles containing soil samples collected solely for lithologic description from each monitoring well boring will be consecutively numbered starting with S-1. In addition, the following information shall be recorded on the lid of these sample jars:

- Job name and number
- Well number and sample number
- Date
- Depth of sample
- Blow counts

3.3.4 Monitoring Well Construction/Installation

Overburden wells will be constructed of 2-inch-diameter, flush-joint-threaded, Schedule 40 PVC casing and well screens equipped with a PVC end plug. Each section of casing and screen shall be NSF-approved. Figure 3-2 illustrates typical well construction details for overburden wells. Monitoring well construction details for the wells to be installed in each RFI unit are given in Tables 2-2, 2-9, 2-16, and 2-22 for RFI Units 5, 10, 16, and 17, respectively. The slot size will be determined in the field, but will be no larger than 0.02 inches.



TYPICAL OVERBURDEN MONITORING WELL CONSTRUCTION DETAILS MCAS CHERRY POINT, NC

FIGURE 3-2

NUS CORPORATION

The PVC well installation procedure will consist of backfilling the boring (if required) with a sand/bentonite mix to a depth of approximately 1/2 to 1 foot below the position desired for the bottom of the well screen. The PVC pipe and screen will be placed at the desired depth in the completed boring and the annulus of the boring, around the well screen, and 1 to 3 feet above the well screen will be backfilled with clean silica sand (Nos. 20 and 30 U.S. Standard Sieve size or as determined by the site geologist). A bentonite pellet seal (minimum 2-foot thickness) will then be installed and allowed to hydrate as per the manufacturer's recommendation; the remainder of the annulus of the boring (from the seal to ground surface) will then be backfilled with cement/bentonite grout placed using a tremie pipe. The depths of all backfill materials will be constantly monitored during the well installation process by means of a weighted stainless steel or plastic tape.

A 4-inch-diameter protective steel casing equipped with a locking steel cap will be installed around all wells. These casings will be grouted a minimum of 3 feet into the ground and will have at least one drain hole positioned approximately 0.5 feet above the ground surface. In addition, a concrete apron measuring 5 feet by 5 feet by 0.5 feet will be constructed equally portioned around the casing of each well. Four marker posts (4-inch nominal diameter, 7-foot-long steel pipe filled with cement) will be embedded in each concrete apron. The marker posts will be positioned equidistant from one another and near the corners of the concrete apron. All locks supplied for the wells will be keyed alike. After installation, the ground surface, the top of the riser pipe, and the top of the protective casing will be surveyed to within 0.01-foot vertical accuracy. In addition, the well will be surveyed to a 0.1-foot horizontal accuracy.

A monitoring well construction diagram will be completed for each well installed. A sample of the monitoring well construction form is provided in Appendix A.

3.3.5 Well Development

Monitoring wells will be developed after installation to remove fines and sediments from around the well screens and to remove drill cuttings and residual drilling fluids from the area around the monitored interval of the boring. Wells will be developed by air lift, bailing and surging, or by pumping, as determined by the field geologist. Wells will be developed until water removed is visibly clear of suspended solids or until approved by the field geologist. The regular pH and specific conductance measurements will be collected for the purged water. Wells will be developed until these readings become stable and when the purged water is visibly clear, as described above. Development water will be discharged onto the ground in the vicinity of the well being developed and in a manner that minimizes surface disturbance and/or runoff.

3.3.6 Aquifer Testing

Monitoring wells will be used for aquifer testing to determine the groundwater flow conditions in the water-bearing zones investigated by each well. The data generated from these tests will be used to define the water-yielding characteristics of each formation, develop groundwater velocity values, and estimate the rate of groundwater movement throughout the site. Slug tests will be performed in each of the monitoring wells, which will then be evaluated using the most appropriate evaluation technique for the existing hydrogeologic conditions. Pressure transducers and data loggers will be used for data collection, where appropriate, to obtain sufficiently accurate field data. Procedures for performing aquifer testing will be in accordance with NUS SOP GH-2.4, Section 5 (See Appendix A).

At a minimum, the following information will be collected (when applicable) for each well during the performance of aquifer tests:

- Well number/depth/screened interval/inside diameter of screen/diameter of sand pack
- Static water level
- Method of inducing water-level change (for slug tests)
- Total time of test

Data generated by the tests will be documented on the appropriate data sheets and analyzed for the determination of aquifer characteristics. Section 5.3 of NUS SOP GH-2.4 summarizes various methods which may be used slug testing data analysis. A sample data sheet for slug tests is provided in Appendix A.

3.3.7 Water-Level Measurements

Synoptic water-level measurements will be taken from all existing and newly installed monitoring wells in RFI Units 5, 10, 16 and 17. In addition, synoptic water-level measurements will be taken from existing monitoring wells in RFI Unit 15. To minimize the potential influence of tides on the water levels, synoptic water-level measurements within a unit will be taken as quickly as possible (within a 4-hour period for RFI Unit 5 and RFI Unit 10). Because RFI Units 15, 16, and 17 are located in close proximity to each other, synoptic water-level measurements from the wells in these units will be taken together as quickly as possible (within a 4-hour period). To minimize potential tidal effects, wells closest to the Neuse River and its tributaries will be measured first, and wells located furthest inland will be measured last. The exact sampling sequence will be determined in the field by the site geologist.

A second round of water-level measurements will be taken from all newly installed wells within a 24-hour period to minimize atmospheric/precipitation effects on groundwater conditions. Measurements will be taken with an M-scope (electrical water-level indicator), pressure transducer, steel tape and chalk, or popper, using the top of the well casing as the reference point for determining depths to water. Water-level measurements will be recorded to the nearest 0.01 foot in the appropriate field log book.

In addition to the static water-level measurements, a continuous recorder will be placed on one new well in RFI Units 5, 10, and 17 for a 1-week period. A continuous recorder is currently in place at RFI Unit 16.

3.3.8 Reporting

The following reports and documentation will be the responsibility of the field geologist during the drilling activities. A copy of applicable forms that will be used by the site geologist are located in Appendix A for the following:

- Soil Boring Description Log
- Overburden Monitoring Well Construction Sheet
- Data Sheet for Slug Test

The field geologist's logbook shall contain information about the drilling activities such as start/finish times, standby times, and problems or changes encountered during drilling. Drilling/ monitoring well construction information (e.g., footage drilled, depth of casing, etc.) will be recorded daily on the boring log and the overburden monitoring well sheet. The boring log, along with the geologist's logbook, will be used to prepare the Daily Activities Record Form. This report will identify drilling activity and quantities of material used on a daily basis, and shall be signed by the drilling contractor foreman (or equivalent) and the site geologist. The reports shall be submitted to the NUS Project Manager at the completion of each well installation. These reports will also be used to fill out the Site Logbook.

3.4 GENERAL SAMPLING OPERATIONS

3.4.1 Soil Samples Collected Using Hand Equipment

From RFI Unit 17, soil samples for laboratory chemical analysis will be collected from just below the surface, from approximately from two feet beneath the ground surface, and from just above the water table (approximately 2-4 feet). A total of 23 soil samples will be collected for chemical analysis using hand equipment as described in Section 2.4.3.2. Stainless steel equipment such as spoons, hand augers, shovels, or scoops shall be used to collect soil samples. The equipment shall be properly decontaminated (see Section 3.6 for decontamination procedures) prior to usage.

If sampling occurs where a vegetative cover has been established, the turf shall be removed and set aside during the sampling operations. The turf shall be replaced after sampling is completed. When the soil sample is obtained, it shall be deposited into a glass or stainless steel bowl for mixing prior to filling the sample containers. Mixing of the soil sample for chemical analysis shall be performed using a stainless steel spoon in the glass or stainless steel mixing bowl. The soil will be homogeneously mixed and then placed into the respective containers for packaging and shipment to the laboratory for chemical analysis. If this material is not a major constituent of the soil, large gravel- or cobble-size material which displays no visible porosity (e.g., quartz or feldspar) or evidence of contaminant staining of the rock surface, will be selectively discarded from the sample.

Prior to sampling surface soils, leaves, grass, and surface debris should be removed from the area to be sampled using a clean stainless steel spoon or shovel. Surface soil samples shall then be collected using a precleaned, stainless steel scoop, trowel, or spoon. Shallow soil samples shall be collected by digging a hole or trench with a stainless steel shovel, then removing all of the loose soil and collecting a sample at the desired depth using a stainless steel spoon, trowel, or scoop. Soil samples will be preserved in accordance with NUS SOP SF-1.2, Section 5 (See Appendix A). Preservation requirements can be found in Table 3-1.

3.4.2 Groundwater Sampling

One round of groundwater samples will be collected from new and existing wells as described in Sections 2.1 through 2.4. Groundwater samples will be collected in accordance with NUS SOP SA-1.1, Section 5 (Appendix A).

Prior to obtaining samples, the static water level and well depth will be measured and the wells will be purged using a dedicated stainless steel bailer or a suction pump. Three to five well volumes will be purged. If the wells are purged dry with less than three well volumes removed, the water level in the well will be allowed to recover at least 70 percent, then a sample will be collected. In the event that recovery is slow, samples will be collected the following day.

Field measurements shall be taken on the groundwater as it is purged and prior to sampling. These field measurements include:

- pH
- Specific conductance
- Temperature

In addition, color and turbidity shall be noted on the sample log form for each water sample obtained and for each purged well volume. Procedures for obtaining these field measurements will be in accordance with NUS SOP SF-1.1 (Sections 5.1, 5.2, and 5.3, respectively). Both filtered and unfiltered samples will be obtained for metals analysis (see Table 3-1). Filtering of samples shall be conducted in accordance with SOP SF-1.2 (Section 5.2.5) in Appendix A.

Dedicated stainless steel bailers will be used for sample collection. The sample will be poured directly from the bailer into the appropriate sample bottles for analysis.

Groundwater samples will be preserved in accordance with NUS SOP SF-1.2, Section 5 (See Appendix A). Preservation requirements are listed in Table 3-1.

All pertinent field data shall be recorded using a Groundwater Sample Log Sheet (in Appendix B) and the field log book.

3.4.3 Surface Water and Sediment Sampling

Surface and sediment samples will be collected from various locations as described in Sections 2.1 through 2.4. Field Technicians will adhere to NUS SOP SA-1.2 Sections 5.3 and 5.4 for all surface water and sediment sampling activities.

In addition, field measurements will be obtained on the surface water samples prior to sample collection. These field measurements include:

- pH
- Specific conductance
- Temperature
- Dissolved oxygen

Color and turbidity shall also be noted on the sample log form for each surface water sample. Procedures for obtaining these field measurements will be in accordance with NUS SOP SF-1.1 (Sections 5.1, 5.2, and 5.3, respectively).

Surface water and sediment samples will be preserved in accordance with NUS SOP SF-1.2, Section 5 (see Appendix A). Preservation requirements are listed in Table 3-1.

All pertinent field data shall be recorded using Sample Log Sheets (example forms are presented in Appendix A) and the field log book.

3.5 SAMPLE ANALYSIS

Samples collected at the four RFI Units will be submitted for the laboratory analyses presented in the medium-specific summary tables in Sections 2.1 through 2.4. These tables indicate the analytical parameters, analytical methods, and QA/QC sample requirements for each sample. Table 3-1 summarizes the analyses, bottle requirements, preservation requirements, and holding times for each sample.

3.6 DECONTAMINATION

The equipment involved in field sampling activities will be decontaminated prior to and during drilling and sampling activities. Such equipment includes drilling rigs, downhole tools, augers, pumps, well casing and screens, soil and water sampling equipment, and water level measurement devices.

3.6.1 Major Equipment

All drilling equipment, including the drill rig and its transport system, shall be steam cleaned prior to beginning work, between the drilling of separate boreholes, any time the drilling rig leaves the facility or unit prior to completing a boring, and at the conclusion of the drilling program.

Decontamination operations will consist of washing equipment using a high-pressure steam wash. All decontamination activities will take place over an onsite area to be designated during mobilization. Additional requirements for drilling equipment decontamination can be found in NUS SOP GH-1.6, Section 5 (Appendix A).

3.6.2 Sampling Equipment

All sampling equipment used for collecting samples will be decontaminated both prior to sampling in the field and between samples. Decontamination procedures will be in accordance with NUS SOP SF-2.3, Section 5 (See Appendix A). In general, the following decontamination steps will be taken:

- Potable water rinse
- Alconox or liquinox detergent wash
- Potable water rinse
- Distilled/deionized water rinse
- Nitric acid rinse
- Distilled/deionized water rinse
- Acetone or methanol double rinse
- Distilled/deionized water rinse
- Air dry

Field analytical equipment such as instrument probes will be rinsed first with distilled/deionized water then with sample.

3.6.3 Personnel

Personnel decontamination is discussed in the Health and Safety Plan included in Appendix B.

4.0 SAMPLING ANALYSIS

4.1 LABORATORY PROCEDURES FOR SAMPLE ANALYSIS

All analysis will be performed using method references from "Test Methods for Evaluating Solids Waste, Physical/Chemical Methods," SW-846, 3rd edition, where applicable. For those tests for which methods are not found in SW-846, other EPA-approved methods will be used. All detection limits listed on the table apply to clean-water samples that are free of matrix interferences. All analytical procedures are performed according to a written method taking one of the two forms described below.

- A legible photocopy of the EPA referenced method with a cover page containing approval signatures and delineating safety precautions, calibration and quality control checks, example calculations, reporting limits, or any other information not fully specified in the reference method.

- A reference method rewritten into NUS standard format, incorporating specific quality control procedures, instrumentation set-up, operation procedures, etc. This method will address the following.

  - Title - List the property, analyte, or class of compounds measured by the method.

  - Scope and Application - Describes the sample matrices to which the procedure applies.

  - Summary of Method - Briefly describes the theory and the steps involved in the method.

  - Interferences - Describes those matrix components known to interfere in the analysis and the methods when available, for preventing or compensating for an interference.

  - Procedure - Describes the sequence of activities to be performed. This includes standardization, sample pretreatment, sample quantitation, reporting limits, quality control checks, and special glassware cleaning procedures or safety precautions as appropriate to the method.

- Apparatus and Materials - Lists the required equipment.

- Reagents - List the reagents used in the method. Describes the required reagent grades plus the reagent preparation, storage requirements, and expiration times.

- References - Lists the reference methods(s) from which information was derived to prepare the method.

All analyses will be completed using Level C protocols, as appropriate. These protocols are described in Section 9.0 of the "NUS Corporation Laboratory Quality Assurance Plan in Support of the Department of the Navy Requirements for Quality Control of Analytical Data."

The laboratory quality assurance project plan (QAPP) referenced above will be used to complete the analytical portion of this program. This QAPP addresses, among other things, all of the following:

- Chain-of-custody procedures
- Sample storage
- Calibration procedures and frequency
- Data reduction, validation, and reporting
- Internal quality control checks
- Laboratory performance and systems audits
- Preventive maintenance procedures and schedules
- Corrective action

Table 4-1 provides a summary of the location of each of these elements within the laboratory QAPP.

Turnaround times for completion of the analyses and generation of reports and data packages depend on several factors, including:

- Number of samples and matrix
- Current laboratory backlog
- Sampling schedule
- Specific required analyses

TABLE 4-1

SAMPLE ANALYSIS REQUIREMENT AND LOCATION
IN LABORATORY QAPP
MCAS, CHERRY POINT, NORTH CAROLINA

Requirement	2.3	4.5	4.6	7.0	9.2	9.5	9.6	10.0	12.0	13.0	C	F	H	J	Table 1
Chain-of-Custody Procedures	X	X	X								X				
Sample Storage			X								X				
Holding Times															X
Sample Preparation Methods and Analytical Procedures															X
Calibration Procedures and Frequency					X	X	X								
Data Reduction, Validation, and Reporting									X				X		
Internal Quality Control Checks					X	X	X								
Systems Audits										X					
Preventive Maintenance				X								X			
Corrective Action								X			X			X	

Typical turnaround time for Level C analysis and generation of data packages is 40 days from receipt of the level sample in a sample delivery group. Expedited turnaround can be provided if scheduled in advance.

4.2 PROTOCOLS FOR DATA EVALUATION

As mentioned previously in Section 4.1, the analytical laboratory will perform data reduction, validation, and reporting tasks. This validation, as performed by the laboratory, is part of the laboratory's internal QA/QC program conducted (under contract) to monitor the laboratory's performance in meeting contract specified quality criteria. The purpose of this validation is to flag non-compliant occurrences, to determine if re-analyses are necessary and to perform those re-analyses as required.

In addition to this laboratory contract compliance validation, data utility is addressed by means of a comprehensive data evaluation (i.e., formal data validation) conducted by NUS non-laboratory staff scientist. The function of this formal data validation is to provide interpretation of the data, determine the impact of the non-compliant occurrences and to lend guidance as to the proper usage and limitations of the data.

All data generated (i.e., organic, inorganic, and miscellaneous inorganic parameters) will be validated according to the following EPA national protocols:

- "Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses"
- "Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses"

As per the EPA national protocols, the following general parameters will be evaluated:

- Data completeness
- Holding times
- Initial and continuing calibration
- Laboratory blank analyses
- Laboratory Duplicate analyses
- Matrix spike analyses
- Detection Limits
- Sample Quantitation

As shown below, parameters specific to the nature of the analyses conducted will also be evaluated:

- Surrogate spike recovery (organics only)
- Internal standards performance (organics only)
- Interference check sample analyses (inorganics only)
- Laboratory control sample results (inorganics only)
- Furnace atomic absorption results (inorganics only)
- Serial dilution analyses (inorganics only)

Field QA/QC data such as field, trip, and rinsate blank analysis results and field duplicate analysis results are included as part of the formal data validation.

The validation described above is documented in memoranda to the file (complete with support documentation) per each data package evaluated. Data validation memos are QA-checked by the NUS Data Validation Coordinator prior to submittal to the NUS Project Manager.

The ensurance of data accuracy and integrity through the data validation process is essential to overall quality of the data and in providing a secure platform for risk assessment decisions.

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APPENDIX A

A.1 STANDARD OPERATING PROCEDURES
A.2 EXAMPLE FORMS

APPENDIX A-1

STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS
APPENDIX A-1

1.0 PURPOSE

The purpose of this procedure is to provide general reference information on the sampling of groundwater wells. The methods and equipment described are for the collection of water samples from the saturated zone of the subsurface.

2.0 SCOPE

This procedure provides information on proper sampling equipment and techniques for groundwater sampling. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The techniques described shall be followed whenever applicable, noting that site-specific conditions or project-specific plans may require adjustments in methodology.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

<u>Site Hydrogeologist or Geochemist</u> - responsible for selecting and detailing the specific groundwater sampling techniques and equipment to be used, documenting these in the Project Operations Plan (POP), and properly briefing the site sampling personnel.

<u>Site Geologist</u> - The Site Geologist is primarily responsible for the proper acquisition of the groundwater samples. When appropriate, such responsibilities may be performed by other qualified personnel (engineers, field technicians).

<u>Site Manager</u> - The Site Manager is responsible for reviewing the sampling procedures used by the field crew and for performing in-field spot checks for proper sampling procedures.

5.0 PROCEDURES

5.1 GENERAL

To be useful and accurate, a groundwater sample must be representative of the particular zone of the water being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of sampling to the time of testing in order to keep any changes in water quality parameters to a minimum.

Methods for withdrawing samples from completed wells include the use of pumps, compressed air, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of the groundwater are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water due to sampling techniques. In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant. To safeguard against collecting non-representative stagnant water in a sample, the following approach shall be followed prior to sample acquisition:

- All monitoring wells shall be purged prior to obtaining a sample. Evacuation of three to five volumes is recommended for a representative sample. In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, evacuation prior to sample withdrawal is not as critical.

2. For wells that can be purged to dryness with the sampling equipment being used, the well shall be evacuated and allowed to recover prior to sample acquisition. If the recovery rate is fairly rapid, evacuation of more than one volume of water is preferred.

3. For high-yielding monitoring wells which cannot be evacuated to dryness, there is no absolute safeguard against contaminating the sample with stagnant water. One of the following techniques shall be used to minimize this possibility:

- A submersible pump, intake line of a surface pump or bailer shall be placed just below the water surface when removing the stagnant water and lowered as the water level decreases. Three to five volumes of water shall be removed to provide reasonable assurance that all stagnant water has been evacuated. Once this is accomplished a bailer may be used to collect the sample for chemical analysis.

- The inlet line of the sampling pump (or the submersible pump itself) shall be placed near the bottom of the screened section, and approximately one casing volume of water shall be pumped from the well at a rate equal to the well's recovery rate.

Stratification of contaminants may exist in the aquifer formation, both in terms of a concentration gradients due to mixing and dispersion processes in a homogeneous layer, and in layers of variable permeability into which a greater or lesser amount of the contaminant plume has flowed. Excessive pumping can dilute or increase the contaminant concentrations in the recovered sample compared to what is representative of the integrated water column at that point, and thus result in the collection of a non-representative sample.

5.2 SAMPLING, MONITORING, AND EVACUATION EQUIPMENT

Sample containers shall conform with EPA regulations for the appropriate contaminants.

The following equipment shall be on hand when sampling ground water wells:

- <u>Sample packaging and shipping equipment</u> - Coolers for sample shipping and cooling, chemical preservatives, appropriate packing containers and filler, ice, labels and chain-of-custody documents.

- <u>Field tools and instrumentation</u> - Thermometer; pH paper/meter; camera and film; tags; appropriate keys (for locked wells); engineers rule; water-level indicator; where applicable, specific-conductivity meter.

- <u>Pumps</u>

  - Shallow-well pumps--Centrifugal, pitcher, suction, or peristaltic pumps with droplines, air-lift apparatus (compressor and tubing) where applicable.

  - Deep-well pumps--submersible pump and electrical power generating unit, or air-lift apparatus where applicable.

- Other sampling equipment - Bailers and monofilament line with tripod-pulley assembly (if necessary). Bailers shall be used to obtain samples for volatile organics from shallow and deep groundwater wells.

- Pails - Plastic, graduated.

- Decontamination solutions - Distilled water, Alconox, methanol, acetone.

Ideally, sample withdrawal equipment shall be completely inert, economical, easily cleaned, sterilized, and reused, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for well flushing and sample collection.

5.3 CALCULATIONS OF WELL VOLUME

To insure that the proper volume of water has been removed from the well prior to sampling it is first necessary to know the volume of standing water in the well pipe. This volume can be easily calculated by the following method. Calculations shall be entered in the field logbook and on the field data form (Attachment A):

- Obtain all available information on well construction (location, casing, screens, etc.).

- Determine well or casing diameter.

- Measure and record static water level (depth below ground level or top of casing reference point).

- Determine depth of well (if not known from past records) by sounding using a clean, decontaminated weighted tape measure.

- Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).

- Calculate one static well volume in gallons ($V = 0.163Tr^2$).

  where:

V	=	Static volume of well in gallons.
T	=	Thickness of water table in the well measured in feet, i.e., linear feet of static water.
r	=	Inside radius of well casing in inches.
0.163	=	A constant conversion factor which compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and pi.

- Determine the minimum amount to be evacuated before sampling.

5.4 EVACUATION OF STATIC WATER (PURGING)

5.4.1 General

The amount of flushing a well shall receive prior to sample collection will depend on the intent of the monitoring program and the hydrogeologic conditions. Programs to determine overall quality of water resources may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume may be specified prior to sampling so that the sample can be a composite of a known volume of the aquifer. Alternately the well can be pumped until the parameters such as temperature, electrical conductance, and pH have stabilized. Onsite measurements of these parameters shall be recorded on the field data form.

For defining a contaminant plume, a representative sample of only a small volume of the aquifer is required. These circumstances require that the well be pumped enough to remove the stagnant water but not enough to induce significant groundwater flow from other areas. Generally three to five well volumes are considered effective for purging a well.

The site hydrogeologist, geochemist and risk assessment personnel shall define the objectives of the groundwater sampling program in the Work Plan, and provide appropriate criteria and guidance to the sampling personnel on the proper methods and volumes of well purging.

5.4.2 Evacuation Devices

The following discussion is limited to those devices commonly used at hazardous waste sites. Attachment B provides guidance on the proper evacuation device to use for given sampling situations. Note that all of these techniques involve equipment which is portable and readily available.

Bailers - Bailers are the simplest evacuation devices used and have many advantages. They generally consist of a length of pipe with a sealed bottom (bucket-type bailer) or, as is more useful and favored, with a ball check-valve at the bottom. An inert line is used to lower the bailer and retrieve the sample.

Advantages of bailers include:

- Few limitations on size and materials used for bailers.
- No external power source needed.
- Bailers are inexpensive, and can be dedicated and hung in a well to reduce the chances of cross-contamination.
- There is minimal outgassing of volatile organics while the sample is in the bailer.
- Bailers are relatively easy to decontaminate.

Limitations on the use of bailers include the following:

- It is time consuming to remove stagnant water using a bailer.
- Transfer of sample may cause aeration.
- Use of bailers is physically demanding, especially in warm temperatures at protection levels above Level D.

Suction Pumps - There are many different types of inexpensive suction pumps including centrifugal, diaphragm, peristaltic, and pitcher pumps. Centrifugal and diaphragm pumps can be used for well evacuation at a fast pumping rate and for sampling at a low pumping rate. The peristaltic pump is a low volume pump (therefore not suitable for well purging) that uses rollers to squeeze a flexible tubing, thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination. The pitcher pump is a common farm hand-pump.

These pumps are all portable, inexpensive and readily available. However, because they are based on suction, their use is restricted to areas with water levels within 20 to 25 feet of the ground surface. A significant limitation is that the vacuum created by these pumps can cause significant loss of dissolved gases and volatile organics. In addition, the complex internal components of these pumps may be difficult to decontaminate.

Gas-Lift Samplers

This group of samplers uses gas pressure either in the annulus of the well or in a venture to force the water up a sampling tube. These pumps are also relatively inexpensive. Gas lift samplers are more suitable for well development than for sampling because the samples may be aerated, leading to pH changes and subsequent trace metal precipitation or loss of volatile organics.

Submersible Pumps

Submersible pumps take in water and push the sample up a sample tube to the surface. The power sources for these samplers may be compressed gas or electricity. The operation principles vary and the displacement of the sample can be by an inflatable bladder, sliding piston, gas bubble, or impeller. Pumps are available for 2-inch diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet).

Limitations of this class of pumps include:

- They may have low delivery rates.
- Many models of these pumps are expensive.
- Compressed gas or electric power is needed.
- Sediment in water may cause clogging of the valves or eroding the impellers with some of these pumps.
- Decontamination of internal components is difficult and time-consuming.

5.5 SAMPLING

5.5.1 Sampling Plan

The sampling approach consisting of the following, shall be developed as part of the POP prior to the field work:

- Background and objectives of sampling.

- Brief description of area and waste characterization.

- Identification of sampling locations, with map or sketch, and applicable well construction data (well size, depth, screened interval, reference elevation).

- Intended number, sequence volumes, and types of samples. If the relative degrees of contamination between wells is unknown or insignificant, a sampling sequence which facilitates sampling logistics may be followed. Where some wells are known or strongly suspected of being highly contaminated, these shall be sampled last to reduce the risk of cross-contamination between wells as a result of the sampling procedures.

- Sample preservation requirements.

- Working schedule.

- List of team members.
- List of observers and contacts.
- Other information, such as the necessity for a warrant or permission of entry, requirement for split samples, access problems, location of keys, etc.

5.5.2 Sampling Methods

The collection of a groundwater sample is made up of the following steps:

1. HSO or designee will first open the well cap and use volatile organic detection equipment (HNU or OVA) on the escaping gases at the well head to determine the need for respiratory protection.
2. When proper respiratory protection has been donned, sound the well for total depth and water level (using clean equipment) and record these data in a well sampling data sheet (Attachment A); then calculate the fluid volume in the well pipe.
3. Calculate well volume to be removed as stated in Section 5.3.
4. Select appropriate purging equipment (see Attachment B). If an electric submersible pump with packer is chosen, go to Step 10.
5. Lower purging equipment or intake into the well to a short distance below the water level and begin water removal. Collect the purged water and dispose of it in an acceptable manner. Lower the purging device, as required, to maintain submergence.
6. Measure rate of discharge frequently. A bucket and stopwatch are most commonly used; other techniques include using pipe trajectory methods, weir boxes or flow meters.
7. Observe peristaltic pump intake for degassing "bubbles." If bubbles are abundant and the intake is fully submerged, this pump is not suitable for collecting samples for volatile organics. Never collect volatile organics samples using a vacuum pump.
8. Purge a minimum of three-to-five casing volumes before sampling. In low permeability strata (i.e., if the well is pumped to dryness), one volume will suffice.
9. If sampling using a pump, lower the pump intake to midscreen or the middle of the open section in uncased wells and collect the sample. If sampling with a bailer, lower the bailer to sampling level before filling (this requires use of other than a 'bucket-type' bailer) Purged water shall be collected in a designated container and disposed of in an acceptable manner.
10. (For pump and packer assembly only). Lower assembly into well so that packer is positioned just above the screen or open section and inflate. Purge a volume equal to at least twice the screened interval or unscreened open section volume below the packer before sampling. Packers shall always be tested in a casing section above ground to determine proper inflation pressures for good sealing.
11. In the event that recovery time of the well is very slow (e.g., 24 hours), sample collection can be delayed until the following day. If the well has been bailed early in the morning,

sufficient water may be standing in the well by the day's end to permit sample collection. If the well is incapable of producing a sufficient volume of sample at any time, take the largest quantity available and record in the logbook.

12. Add preservative if required. Label, tag, and number the sample bottle(s).

13. Replace the well cap. Make sure the well is readily identifiable as the source of the samples.

14. Pack the samples for shipping. Attach a custody seal to the front and back of the shipping package. Make sure that traffic reports and chain-of-custody forms are properly filled out and enclosed or attached.

15. Decontaminate all equipment

5.5.3 Sample Containers

For most samples and analytical parameters, either glass or plastic containers are satisfactory.

5.5.4 Preservation of Samples and Sample Volume Requirements

Sample preservation techniques and volume requirements depend on the type and concentration of the contaminant and on the type of analysis to be performed. Procedure SF-1.2 describes the sample preservation and volume requirements for most of the chemicals that will be encountered during hazardous waste site investigations. Procedure SA-4.3 describes the preservation requirement for microbial samples.

5.5.5 Handling and Transporting Samples

After collection, samples shall be handled as little as possible. It is preferable to use self-contained "chemical" ice (e.g., "blue ice") to reduce the risk of contamination. If water ice is used, it shall be bagged and steps taken to ensure that the melted ice does not cause sample containers to be submerged and thus possibly become cross-contaminated. All sample containers shall be enclosed in plastic bags or cans to prevent cross-contamination. Samples shall be secured in the ice chest to prevent movement of sample containers and possible breakage. Sample packing and transportation requirements are described in SA-6.2.

5.5.6 Sample Holding Times

Holding times (i.e. allowed time between sample collection and analysis) for routine samples are given in Procedure SF-1.2.

5.6 RECORDS

Records will be maintained for each sample that is taken. The sample log sheet will be used to record the following information:

- Sample identification (site name, location, project number; sample name/number and location; sample type and matrix; time and date; sampler's identity).
- Sample source and source description.

- Purge data - prior to removal of each casing volume and before sampling, pH, electrical conductance, temperature, color, and turbidity shall be measured and recorded.

- Field observations and measurements (appearance; volatile screening; field chemistry; sampling method).

- Sample disposition (preservatives added; lab sent to, date and time; lab sample number, EPA Traffic Report or Special Analytical Services number, chain-of-custody number.

- Additional remarks - (e.g., sampled in conjunction with state, county, local regulatory authorities; samples for specific conductance value only; sampled for key indicator analysis; etc.).

5.7 CHAIN-OF-CUSTODY

Proper chain-of-custody procedures play a crucial role in data gathering. Procedure SA-6.1 describes the requirements for a correct chain-of-custody.

6.0 REFERENCES

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7.0 RECORDS

Attachment A - Well Sampling Data Sheet
Attachment B - Purging Equipment Selection

Manufacturer	Model name/number	Principle of operation	Maximum outside diameter/length (inches)	Construction materials (w/lines & tubing)	Lift range (ft)	Delivery rates or volumes	1982 price (dollars)	Comments
BarCad Systems, Inc.	BarCad Sampler	dedicated; gas drive (positive displacement)	1.5/16	PE, brass, nylon, aluminum oxide	0-150 with std tubing	1 liter for each 10-15 ft of submergence	220-350	requires compressed gas; custom sizes and materials available; acts as piezometer
Cole-Parmer Inst. Co.	Master Flex 7570 Portable Sampling Pump	portable; peristaltic (suction)	<1.0/NA	(not submersible) Tygon®, silicone Viton®	0-30	670 mL/min with 7015-20 pump head	500-600	AC/DC; variable speed control available; other models may have different flow rates
ECO Pump Corp.	SAMPLifier	portable; venturi	<1.5 or <2.0/NA	PP, PE, PVC, SS, Teflon®, Tefzel®	0-100	0-500 mL/min depending on lift	400-700	AC, DC, or gasoline driven motors available; must be primed
Galtek Corp.	Bailer 219-4	portable; grab (positive displacement)	1.66/38	Teflon®	no limit	1076 mL	120-135	other sizes available
GeoEngineering, Inc.	GEO-MONITOR	dedicated; gas drive (positive displacement)	1.5/16	PE, PP, PVC, Viton®	probably 0-150	app. 1 liter for each 10 ft of submergence	185	acts as piezometer; requires compressed gas
Industrial and Environmental Analysts, Inc. (IEA)	Aquarius	portable; bladder (positive displacement)	1.75/43	SS, Teflon®, Viton®	0-250	0-2800 mL/min	1600-3000	requires compressed gas; other models available; AC, DC, manual operation possible
IEA	Syringe Sampler	portable; grab (positive displacement)	1.75/43	SS, Teflon®	no limit	850 mL sample vol.	1100	requires vacuum and/or pressure from hand pump
Instrument Specialties Co. (ISCO)	Model 2600 Well Sampler	portable; bladder (positive displacement)	1.75/50	PC, silicone, Teflon®, PP, PE, Delrin®, acetal	0-150	0-7500 mL/min	990	requires compressed gas (40 psi minimum)
Keck Geophysical Instruments, Inc.	SP-81 Submersible Sampling Pump	portable; helical rotor (positive displacement)	1.75/25	SS, Teflon®, PP, EPDM, Viton®	0-160	0-4500 mL/min	3500	DC operated
Leonard Mold and Die Works, Inc.	GeoFilter Small Dia. Well Pump (#0500)	portable; bladder (positive displacement)	1.75/38	SS, Teflon®, PC, Neoprene®	0-400	0-3500 mL/min	1400-1500	requires compressed gas (65 PSI minimum); pneumatic or AC/DC control module
Oil Recovery Systems, Inc.	Surface Sampler	portable; grab (positive displacement)	1.75/12	acrylic, Delrin®	no limit	app. 250 mL	125-160	other materials and models available; for measuring thickness of "floating" contaminants
Q.E.D. Environmental Systems, Inc.	Well Wizard® Monitoring System (P-100)	dedicated; bladder (positive displacement)	1.66/36	PVC	0-230	0-2000 mL/min	300-400	requires compressed gas; piezometric level indicator; other materials available

Source: Barcelona et al., 1983

Manufacturer	Model name/number	Principle of operation	Maximum outside diameter/length (inches)	Construction materials (w/lines & tubing)	Lift range (ft)	Delivery rates or volumes	1982 price (dollars)	Comments
Randolph Austin Co.	Model 500 Vari Flow Pump	portable, peristaltic (suction)	<0.5/N/A	(not submersible) rubber, Tygon®, or Neoprene®	0-30	see comments	1200-1300	flow rate dependent on motor and tubing selected. AC operated, other models available
Robert Bennett Co.	Model 180	portable, piston (positive displacement)	1.8/22	SS, Teflon®, Delrin®, PP, Viton®, acrylic, PE	0-500	0-1800 mL/min	2600-2700	requires compressed gas, water level indicator and flow meter, custom models available
Slope Indicator Co. (SINCO)	Model 514124 Pneumatic Water Sampler	portable, gas drive (positive displacement)	1.9/18	PVC, nylon	0-1100	250 mL/flushing cycle	250-350	requires compressed gas, SS available, piezometer model available, dedicated model available
Solinst Canada Ltd.	5W Water Sampler	portable, grab (positive displacement)	1.9/27	PVC, brass, nylon, Neoprene®	0-330	500 mL	1300-1800	requires compressed gas, custom models available
TIMCO Mfg. Co., Inc.	Std. Bailer	portable, grab (positive displacement)	1.66/custom	PVC, PP	no limit	250 mL/ft of bailer	20-60	other sizes, materials, models available, optional bottom-emptying device available; no solvents used
TIMCO	Air or Gas Lift Sampler	portable, gas drive (positive displacement)	1.66/30	PVC, Tygon®, Teflon®	0-150	350 mL/flushing cycle	100-200	requires compressed gas, other sizes, materials, models available, no solvents used
Tole Devices Co.	Sampling Pump	portable, bladder (positive displacement)	1.38/48	SS, silicone, Delrin®, Tygon®	0-125	0-4000 mL/min	800-1000	compressed gas to pump, DC control module, custom built

Construction Materials Abbreviations

PE	Polyethylene
PP	Polypropylene
PVC	Polyvinyl Chloride
SS	Stainless Steel
PC	Polycarbonate
EPDM	Ethylene-Propylene Diene (synthetic rubber)

Other Abbreviations

NA	Not Applicable
AC	Alternating Current
DC	Direct Current

NOTE: Other manufacturers market pumping devices which could be used for ground water sampling, though not expressly designed for this purpose. The list is not meant to be all-inclusive and listing does not constitute endorsement for use. Information in the table is from sales literature and/or personal communication. No skimmer, scavenger type, or high capacity pumps are included.

Source: Barcelona et al., 1983

GROUNDWATER SAMPLE ACQUISITION

1

08/10/88

NUS CORPORATION
A Halliburton Company

SAMPLE LOG SHEET

- [ ] Monitoring Well Data
- [ ] Domestic Well Data
- [ ] Other ____________

Page ____ of ____

Case # ____________

By ____________

Project Site Name ______________________ Project Site Number ______________

NUS Source No. ______________________ Source Location ______________

	Purge Data				
Total Well Depth:	Volume	pH	S.C.	Temp. (°C)	Color & Turbidity
Well Casing Size & Depth:					
Static Water Level:					
One Casing Volume:					
Start Purge (hrs.):					
End Purge (hrs.):					
Total Purge Time (min.):					
Total Amount Purged (gal.):					
Monitor Reading:					
Purge Method:					
Sample Method:					
Depth Sampled:					

	Sample Data			
Sample Date & Time:	pH	S.C.	Temp. (°C)	Color & Turbidity
Sampled By:				

Signature(s):	Observations / Notes:
Type of Sample - [ ] Low Concentration - [ ] High Concentration - [ ] Grab - [ ] Composite - [ ] Grab - Composite	

Analysis:	Preservative		Organic	Inorganic
		Traffic Report #		
		Tag #		
		AB #		
		Date Shipped		
		Time Shipped		
		Lab		
		Volume		

ATTACHMENT A

ATTACHMENT B

Purging Equipment Selection

Diameter Casing	Bailer	Peristaltic Pump	Vacuum Pump	Airlift	Diaphragm "Trash" Pump	Submersible Diaphragm Pump	Submersible Electric Pump	Submersible Electric Pump w/Packer
1.25-inch								
Water level <25 ft		x	x	x	x			
Water level >25 ft				x				
2-inch								
Water level <25 ft	x	x	x	x	x	x		
Water level >25 ft	x			x		x		
4-inch								
Water level <25 ft	x	x	x	x	x	x	x	x
Water level >25 ft	x			x		x	x	x
6-inch								
Water level <25 ft				x	x		x	x
Water level >25 ft				x			x	x
8-inch								
Water level <25 ft				x	x		x	x
Water level >25 ft				x			x	x

5.3 SURFACE WATER SAMPLE COLLECTION

5.3.1 Streams, Rivers, Outfalls and Drainage Features (Ditches, Culverts)

Methods for sampling streams, rivers, outfalls and drainage features at a single point vary from the simplest of hand sampling procedures to the more sophisticated multipoint sampling techniques known as the equal-width-increment (EWI) method or the equal-discharge-increment (EDI) methods (see below).

Samples from different depths or cross-sectional locations in the water course taken during the same sampling episode shall be composited. However, samples collected along the length of the watercourse or at different times may reflect differing inputs or dilutions and therefore shall not be composited. Generally, the number and type of samples to be taken depend on the river's width, depth, discharge and on the suspended sediment the river's transports. The greater number of individual points that are sampled, the more likely that the composite sample will truly represent the overall characteristics of the water.

In small streams less than about 20 feet wide, a sampling site can generally be found where the water is well-mixed. In such cases, a single grab sample taken at mid-depth in the center of the channel is adequate to represent the entire cross-section.

For larger streams, at least one vertical composite shall be taken with one sample each from just below the surface, at mid-depth, and just above the bottom. The measurement of DO, pH, temperature, conductivity, etc., shall be made on each aliquot of the vertical composite and on the composite itself. For rivers, several vertical composites shall be collected.

5.3.2 Lakes, Ponds and Reservoirs

Lakes, ponds, and reservoirs have as much greater tendency to stratify than rivers and streams. The relative lack of mixing requires that more samples be obtained.

The number of water sampling sites on a lake, pond, or impoundment will vary with the size and shape of the basin. In ponds and small lakes, a single vertical composite at the deepest point may be sufficient. Similarly, the measurement of DO, pH, temperature, etc., is to be conducted on each aliquot of the vertical composite. In naturally-formed ponds, the deepest point may have to be determined empirically; in impoundments, the deepest point is usually near the dam.

In lakes and larger reservoirs, several vertical composites shall be composited to form a single sample. These verticals are often taken along a transect or grid. In some cases, it may be of interest to form separate composites of epilimnetic and hypolimnetic zones. In a stratified lake, the epilimnion is the thermocline which is exposed to the atmosphere. The hypolimnion is the lower, "confined" layer which is only mixed with the epilimnion and vented to the atmosphere during seasonal "overturn" (when density stratification disappears). These two zones may thus have very different concentrations of contaminants if input is only to one zone, if the contaminants are volatile (and therefore vented from the epilimnion but not the hypolimnion), or if the epilimnion only is involved in short-term flushing (i.e., inflow from or outflow to shallow streams). Normally, however, a composite consists of several verticals with samples collected at various depths.

In lakes with irregular shape and with bays and coves that are protected from the wind, separate composite samples may be needed to adequately represent water quality since it is likely that only poor mixing will occur. Similarly, additional samples are recommended where discharges, tributaries, land use characteristics, and other such factors are suspected of influencing water quality.

Many lake measurements are now made in-situ using sensors and automatic readout or recording devices. Single and multiparameter instruments are available for measuring temperature, depth, pH, oxidation-reduction potential (ORP), specific conductance, dissolved oxygen, some cations and anions, and light penetration.

5.3.3 Estuaries

Estuarine areas are by definition zones where inland freshwaters (both surface and ground) mix with oceanic saline waters. Estuaries are generally categorized into three types dependent upon freshwater inflow and mixing properties. Knowledge of the estuary type is necessary to determine sampling locations:

- Mixed estuary - characterized by the absence of a vertical halocline (gradual or no marked increase in salinity in the water column) and a gradual increase in salinity seaward. Typically this type of estuary is shallow and is found in major freshwater sheetflow areas. Being well mixed, the sampling location are not critical in this type of estuary.

- Salt wedge estuary - characterized by a sharp vertical increase in salinity and stratified freshwater flow along the surface. In these estuaries the vertical mixing forces cannot override the density differential between fresh and saline waters.. In effect, a salt wedge tapering inland moves horizontally, back and forth, with the tidal phase. If contamination is being introduced into the estuary from upstream, water sampling from the salt wedge may miss it entirely.

- Oceanic estuary - characterized by salinities approaching full strength oceanic waters. Seasonally, freshwater inflow is small with the preponderance of the fresh-saline water mixing occurring near, or at, the shore line.

Sampling in estuarine areas is normally based upon the tidal phases, with samples collected on successive slack tides (i.e. when the tide turns). Estuarine sampling programs shall include vertical salinity measurements at 1 to 5 foot increments coupled with vertical dissolved oxygen and temperature profiles.

5.3.4 Surface Water Sampling Equipment

The selection of sampling equipment depends on the site conditions and sample type required. The most frequently used samplers are:

- Open tube
- Dip sampler
- Hand pump
- Kemmerer
- Depth-Integrating Sampler

The dip sampler and the weighted bottle s... pler are used most often.

The criteria for selecting a sampler include:

- Disposable and/or easily decontaminated
- Inexpensive (if the item is to be disposed of)
- Ease of operation
- Nonreactive/noncontaminating - Teflon-coating, glass, stainless steel or PVC sample chambers are preferred (in that order)

Each sample (grab or each aliquot collected for compositing) shall be measured for:

- Specific conductance
- Temperature
- pH (optional)
- Dissolved oxygen (optional)

as soon as it is recovered. These analyses will provide information on water mixing/stratification and potential contamination.

Dip Sampling

Water is often sampled by filling a container either attached to a pole or held directly, from just beneath the surface of the water (a dip or grab sample). Constituents measured in grab samples are only indicative of conditions near the surface of the water and may not be a true representation of the total concentration that is distributed throughout the water column and in the cross section. Therefore, whenever possible it is recommended to augment dip samples with samples that represent both dissolved and suspended constituents and both vertical and horizontal distributions.

Weighted Bottle Sampling

A grab sample can also be taken using a weighted holder that allows a sample to be lowered to any desired depth, opened for filling, closed, and returned to the surface. This allows discrete sampling with depth. Several of these samples can be combined to provide a vertical composite. Alternatively, an open bottle can be lowered to the bottom and raised to the surface at a uniform rate so that the bottle collects sample throughout the total depth and is just filled on reaching the surface. The resulting sample using either method will roughly approach what is known as a depth-integrated sample.

A closed weighted bottle sampler consists of a stopped glass or plastic bottle, a weight and/or holding device, and lines to open the stopper and lower or raise the bottle. The procedure for sampling is:

- Gently lower the sampler to the desired depth so as not to remove the stopper prematurely (watch for bubbles).

- Pull out the stopper with a sharp jerk of the sampler line.

- Allow the bottle to fill completely, as evidenced by the absence of air bubbles.

- Raise the sampler and cap the bottle.

- Decontaminate the outside of the bottle. The bottle can be used as the sample container (as long as original bottle is an approved container).

Kemmerer

If samples are desired at a specific depth, and the parameters to be measured do not require a Teflon coated sampler, a standard Kemmerer sampler may be used. The Kemmerer sampler is a brass cylinder with rubber stoppers that leave the ends open while being lowered in a vertical position to allow free passage of water through the cylinder. "Messenger" is sent down the line when the sampler is at the designated depth, to cause the stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill sample bottles.

5.3.5 Surface Water Sampling Techniques

Most samples taken during site investigations are grab samples. Typically, surface water sampling involves immersing the sample container in the body of water; however, the following suggestions are made to help ensure that the samples obtained are representative of site conditions:

- The most representative samples are obtained from mid-channel at 0.6 stream depth in a well-mixed stream.
- Even though the containers used to obtain the samples are previously laboratory cleaned, it is suggested that the sample container be rinsed at least once with the water to be sampled before the sample is taken.
- For sampling running water, it is suggested that the farthest downstream sample be obtained first and that subsequent samples be taken as one works upstream. Work from zones suspected of low contamination to zones of high contamination.
- To sample a pond or other standing body of water, the surface area may be divided into grids. A series of samples taken from each grid is combined into one sample, or several grids are selected at random.
- Care should be taken to avoid excessive agitation of the water that results in the loss of volatile constituents.
- When obtaining samples in 40 ml septum vials for volatile organics, analysis, it is important to exclude any air space in the top of the bottle and to be sure that the Teflon liner faces in after the bottle is filled and capped. The bottle can be turned upside down to check for air bubbles.
- Do not sample at the surface, unless sampling specifically for a known constituent which is immiscible and on top of the water. Instead, the sample container should be inverted, lowered to the approximate depth, and held at about a 45-degree angle with the month of the bottle facing upstream.

5.4 SEDIMENT SAMPLING

5.4.1 General

Sediment samples are usually collected at the same verticals at which water samples were collected. If only one sediment sample is to be collected, the site shall be approximately at the center of water body. Generally, the coarser grained sediments are deposited near the headwaters of the reservoir. Bed sediments near the center will be composed of fine-grained materials which may, because of their lower porosity and greater surface area available for adsorption, contain greater concentrations of contaminants. The shape, flow pattern, bathometry (depth distribution), and water circulation patterns must all be considered when selecting sediment sampling sites. In streams, areas likely to have sediment accumulation (bends, behind islands or boulders, quiet shallow areas or very deep, low-velocity areas) shall be sampled while areas likely to show net erosion (high-velocity, turbulent areas) and suspension of fine solid materials shall be avoided.

Chemical constituents associated with bottom material may reflect an integration of chemical and biological processes. Bottom samples reflect the historical input to streams, lakes, and estuaries with respect to time, application of chemicals, and land use. Bottom sediments (especially fine-grained material) may act as a sink or reservoir for adsorbed heavy metals and organic contaminants (even if water column concentrations are below detection limits). It is therefore important to minimize the loss of low-density "fines" during any sampling process.

5.4.2 Sampling Equipment and Techniques

A bottom-material sample may consist of a single scoop or core or may be a composite of several individual samples in the cross section. Sediment samples may be obtained using on-shore or off-shore techniques.

When boats are used for sampling, life preservers must be provided and two individuals must undertake the sampling. An additional person shall remain on-shore in visual contact at all times.

The following samplers may be used to collect bottom materials:

- Scoop sampler
- Dredge samplers

Scoop Sampler

A scoop sampler consists of a pole to which a jar or scoop is attached. The pole may be made of bamboo, wood or aluminum and be either telescoping or of fixed length. The scoop or jar at the end of the pole is usually attached using a clamp.

If the water body can be sampled from the shore or if it can be waded, the easiest and "cleanest" way to collect a sediment sample is to use a scoop sampler. This reduces the potential for cross-contamination. This method is accomplished by reaching over or wading into the water body and, while facing upstream (into the current), scooping in the sample along the bottom in the upstream direction. It is very difficult not to disturb fine-grained materials of the sediment-water interface when using this method.

Dredges

Dredges are generally used to sample sediments which cannot easily be obtained using coring devices (i.e., coarse-grained or partially-cemented materials) or when large quantities of materials are required. Dredges generally consist of a clam shell arrangement of two buckets. The buckets may either close upon impact or be activated by use of a messenger. Most dredges are heavy (up to several hundred pounds) and require use of a winch and crane assembly for sample retrieval. There are three major types of dredges: Peterson, Eckman and Ponar dredges.

The Peterson dredge is used when the bottom is rocky, in very deep water, or when the flow velocity is high. The dredge shall be lowered very slowly as it approaches bottom, because it can force out and miss lighter materials if allowed to drop freely.

The Eckman dredge has only limited usefulness. It performs well where bottom material is unusually soft, as when covered with organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in streams with high flow velocities.

The Ponar dredge is a Peterson dredge modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing the "shock wave" and permitting direct access to the secured sample without opening the closed jaws. The Ponar dredge is easily operated by one person in the same fashion as the Peterson dredge. The Ponar dredge is one of the most effective samplers for general use on all types of substrates. Access to the secured sample through the covering screens permits subsampling of the secured material with coring tubes or Teflon scoops, thus minimizing the change of metal contamination from the frame of the device.

6.0 REFERENCES

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Ebasco Services Incorporated; REM III Field Technical Guideline No. FT-7.08. January 16, 1986.

7.0 RECORDS

None

4.0 RESPONSIBILITIES

- Field Operations Leader - Responsible for determining that chain-of-custody procedures are implemented up to and including release to the shipper.
- Field Samplers - Responsible for initiating the Chain-of-Custody Record and maintaining custody of samples until they are relinquished to another custodian, to the shipper, or to the common carrier.
- Remedial Investigation Leader - Responsible for determining that chain-of-custody procedures have been met by the sample shipper and analytical laboratory.

5.0 PROCEDURES

5.1 OVERVIEW

The term "chain-of-custody" refers to procedures which ensure that evidence presented in a court of law is what it is represented to be. The chain-of-custody procedures track the evidence from the time and place it is first obtained to the courtroom and, secondly, provide security for the evidence as it is moved and/or passes from the custody of one individual to another.

Chain-of-custody procedures, recordkeeping, and documentation are an important part of the management control of samples. Regulatory agencies must be able to provide the chain of possession and custody of any samples that are offered for evidence, or that form the basis of analytical test results introduced as evidence. Written procedures must be available and followed whenever evidence samples are collected, transferred, stored, analyzed, or destroyed.

5.2 SAMPLE IDENTIFICATION

The method of identification of a sample depends on the type of measurement or analysis performed. When in-situ measurements are made, the data are recorded directly in bound logbooks or other field data records, with identifying information.

5.2.1 <u>Sample Label</u>

Samples, other than in-situ measurements, are removed and transported from the sample location to a laboratory or other location for analysis. Before removal, however, a sample is often divided into portions, depending upon the analyses to be performed. Each portion is preserved in accordance with the Sampling Plan. Each sample container is identified by a sample label (see Attachment B) Sample labels are provided by the PMO. The information recorded on the sample label includes:

Project	EPA Work Assignment Number (can be obtained from the Project Operations Plan).
Station Location	The unique sample number identifying this sample (can be obtained from the Project Operations Plan).
Date	A six-digit number indicating the day, month, and year of sample collection; e.g., 12/21/85.
Time	A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.)
Medium	Water, soil, sediment, sludge, waste, etc.
Concentration	The expected concentration (i.e., low, medium, high).
Sample Type	Grab or composite
Preservation	Type of preservation added and pH levels.
Analysis	VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
Sampled By	Printed name of the sampler.
Case #	Case number assigned by the Sample Management Office.
Traffic Report Number	Number obtained from the traffic report labels.
Remarks	Any pertinent additional information.

Using just the EPA work assignment number of the sample label maintains the anonymity of sites. This may be necessary, even to the extent of preventing the laboratory performing analysis from knowing the identity of the site (e.g., if the laboratory is part of an organization that has performed previous work on the site).

5.2.2 Sample Identification Tag

A Sample Identification Tag (Attachment B) must also be used for samples collected for CLP (Contract Laboratory Program) analysis. The Sample Identification Tag is a white, waterproof paper label, approximately 3-by-6 inches, with a reinforced eyelet, and string or wire for attachment to the neck of the sample bottle. The Sample Tag is a controlled document, and is provided by the regional EPA office. Following sample analysis, the Sample Tag is retained by the laboratory as evidence of sample receipt and analysis.

The following information is recorded on the tag:

Project Code	EPA Work Assignment Number.
Station Number	The middle portion of the Station Location Number, (between the hyphens).
Month/Day/Year	Same as Date on Sample Label.
Time	Same as Time on Sample Label.
Designate: Comp/Grab	Composite or grab sample.
Station Location	Same as Station Location on Sample Label.
Samplers	Same as Sampled By on Sample Label.
Preservative	Yes or No.
Analyses	Check appropriate box(es).
Remarks	Same as Remarks on Sample Label (make sure the Case No. and Traffic Report numbers are recorded).
Lab Sample No.	For laboratory use only.

The tag is then tied around the neck of the sample bottle.

If the sample is to be split, it is aliquoted into similar sample containers. Identical information is completed on the label attached to each split.

Blank, duplicate, or field spike samples shall not be identified as such on the label, as they may compromise the quality control function. Sample blanks, duplicates, spikes, and splits are defined in Procedure SA-6.6.

5.3 CHAIN-OF-CUSTODY PROCEDURES

After collection, separation, identification, and preservation, the sample is maintained under chain-of-custody procedures until it is in the custody of the analytical laboratory and has been stored or disposed of.

5.3.1 Field Custody Procedures

- Samples are collected as described in the site-specific Sampling Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the sample log sheet and Chain-of-Custody Record exactly.

- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once developed, the photographic prints shall be serially numbered, corresponding to the logbook descriptions.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions, e.g., a logbook notation would explain that a pencil was used to fill out the sample label because a ballpoint pen would not function in freezing weather.

5.3.2 Transfer of Custody and Shipment

Samples are accompanied by a Chain-of-Custody Record Form. The Chain-of-Custody Record Form used in EPA Region III is shown in Attachment A. The appropriate form shall be obtained from the EPA Regional Office. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record. This Record documents sample custody transfer from the sampler, often through another person, to the analyst in the laboratory. The Chain-of-Custody Record is filled out as follows:

- Enter header information (project number, samplers, and project name -- project name can be obtained from the Project Operations Plan).

- Sign, date, and enter the time under "Relinquished by" entry.

- Enter station number (the station number is the middle portion of the station location number, between the hyphens).

- Check composite or grab sample.

- Enter station location number (the same number as the station location on the tag and label).

- Enter the total number of containers per station number and the type of each bottle.

- Enter either the inorganic traffic report number, the organic traffic report number, or the SAS number for each station number in the remarks column.

- Enter the tag number from the bottom of the sample identification tag in the remarks column for each station location.

- Make sure that the person receiving the sample signs the "Received by" entry, or enter the name of the carrier (e.g., UPS, Federal Express) under "Received by." Receiving laboratory will sign "Received for Laboratory by" on the lower line and enter the date and time.

- Enter the bill-of-lading or Federal Express airbill number under "Remarks," in the bottom right corner, if appropriate.

- Place the original (top, signed copy) of the Chain-of-Custody Record Form in the appropriate sample shipping package. Retain the pink copy with field records.

- Sign and date the custody seal, a 1- by 3-inch white paper label with black lettering and an adhesive backing. Attachment D is an example of a custody seal. The custody seal is part of the chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field. Custody seals are provided by ZPMO on an as-needed basis.

- Place the seal across the shipping container opening so that it would be broken if the container is opened.

- Complete other carrier-required shipping papers.

The custody record is completed using black waterproof ink. Any corrections are made by drawing a line through and initialing and dating the change, then entering the correct information. Erasures are not permitted.

Common carriers will usually not accept responsibility for handling Chain-of-Custody Record Forms; this necessitates packing the record in the sample container (enclosed with other documentation in a plastic zip-lock bag). As long as custody forms are sealed inside the sample container and the custody seals are intact, commercial carriers are not required to sign off on the custody form.

If sent by mail, the package will be registered with return receipt requested. If sent by common carrier or air freight, proper documentation must be maintained.

The laboratory representative who accepts the incoming sample shipment signs and dates the Chain-of-Custody Record, completing the sample transfer process. It is then the laboratory's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis.

5.3.3 Receipt for Samples Form

Whenever samples are split with a private party or government agency, a separate Receipt for Samples Record Form is prepared for those samples and marked to indicate with whom the samples are being split. The person relinquishing the samples to the party or agency shall require the signature of a representative of the appropriate party acknowledging receipt of the samples. If a representative is unavailable or refuses to sign, this is noted in the "Received by" space. When appropriate, as in the case where the representative is unavailable, the custody record shall contain a statement that the samples were delivered to the designated location at the designated time. This form must be completed and a copy given to the owner, operator, or agent-in-charge even if the offer for split samples is declined. The original is retained by the Field Operations Leader.

6.0 REFERENCES

USEPA, 1984. User's Guide to the Contract Laboratory Program, Office of Emergency and Remedial Response, Washington, D.C.

Ebasco Services Incorporated; REM III Field Technical Guideline No. FT-7.04, October 30, 1987.

Ebasco Services Incorporated; REM III Field Technical Guideline No. 7.05, October 30, 1987.

7.0 RECORDS

Attachment A - Chain-of-Custody Record Form for use in Region III
Attachment B - Sample Label
Attachment C - Sample Identification Tag
Attachment D - Chain-of-Custody Seal

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

REGION 3
Curtis Bldg., 6th & Walnut Sts
Philadelphia, Pennsylvania 19106

CHAIN OF CUSTODY RECORD

PROJ. NO. | PROJECT NAME

SAMPLERS: (Signature)

STA. NO.	DATE	TIME	COMP	GRAB	STATION LOCATION	NO. OF CONTAINERS							REMARKS

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature)	Date / Time	Remarks	

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

ATTACHMENT A
CHAIN-OF-CUSTODY RECORD FORM FOR USE IN REGION III
(Original is 8-1/2 x 11-3/4")

3-15966

1.0 PURPOSE

This procedure describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- pH
- Specific Conductance
- Temperature
- Dissolved Oxygen (DO) Concentration
- Oxidation Reduction Potential
- Certain Dissolved Constituents Using Specific Ion Elements

2.0 SCOPE

This procedure is applicable for use in an on-site groundwater quality monitoring program to be conducted during a remedial investigation or site investigation program at a hazardous or non-hazardous site. The procedures and equipment described are applicable to nearly all aqueous samples, including potable well water, monitoring well water, surface water, leachate and drummed water, etc. and are not, in general, subject to solution interferences from color, turbidity and colloidal material, or suspended matter.

This procedure provides generic information for measuring the parameters listed above with instruments and techniques in common use. Since instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use.

3.0 GLOSSARY

3.1 pH MEASUREMENT

pH - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration.

pH Paper - Paper that turns different colors depending on the pH of the solution to which it is exposed. Comparison with color standards supplied by the manufacturer will then give an indication of the solution pH.

3.2 SPECIFIC CONDUCTANCE MEASUREMENT

Ohm - Standard unit of electrical resistance (R). A siemen (or umho) is the standard unit of electrical conductance, the inverse of the ohm

Resistance - A measure of the solution's ability to oppose the passage of electrical current. For metals and solutions, resistance is defined by Ohm's law, $E = IR$, where E is the potential difference, I is the current, and R is the resistance.

Conductance - The conductance of a conductor 1 centimeter long and 1 square centimeter in cross-sectional area. Conductivity and specific conductance are used synonymously.

3.3 TEMPERATURE MEASUREMENT

None

3.4 DISSOLVED OXYGEN MEASUREMENT

Galvanic Cell - An electrochemical cell in which chemical energy is spontaneously converted to electrical energy. The electrical energy produced is supplied to an external circuit.

Electrolytic Cell - An electrochemical cell in which electrical energy is supplied from an external source. This cell functions in much the same way as a galvanic cell, only in the opposite direction due to the external source of applied voltage.

3.5 OXIDATION-REDUCTION POTENTIAL MEASUREMENT

Oxidation - The process in which an atom or group of atoms loses electrons to achieve an increasing positive charge.

Reduction - The gaining of electrons by an atom or group of atoms and subsequent increase in negative charge.

Oxidation-Reduction Potential (ORP) - A measure of the activity ratio of oxidizing and reducing species as determined by the electromotive force developed by a noble metal electrode, immersed in water, as referenced against a standard hydrogen electrode.

3.6 SPECIFIC ION ELECTRODES MEASUREMENT

Specific Ion Electrode - An electrode which develops a potential difference across a membrane in response to the concentration differences for selected ions on either side of that membrane.

4.0 RESPONSIBILITIES

Site Manager - in consultation with the Project Geochemist, is responsible for determining which on-site water quality measurements can contribute to the RI, when these measurements shall be made, and the data quality objectives (DQOs) for these measurements. The Project Operations Plan (POP) shall contain details of type, frequency and locations of the desired measurements.

Project Geochemist - primarily responsible for determining the type, frequency and locations for on-site water quality measurements as presented in the POP and for interpreting the results, including determination of which measurements are unrepresentative.

Field Operations Leader - responsible for implementing the POP, and also for deciding under what field conditions a particular on-site measurement will be unrepresentative or unobtainable.

Field Samplers/Analysts - responsible for the actual analyses that take place, including calibration, quality control and recording of results, as well as for the care and maintenance of the equipment in the field.

The sample used for pH measurement shall never be saved for subsequent conductivity or chemical analysis. All pH electrodes leak small quantities of electrolytes (e.g., sodium or potassium chloride) into the solution. Precipitation of saturated electrolyte solution, especially at colder temperatures, or in cold water, may result in slow electrode response. Any visual observation of conditions which may interfere with pH measurement, such as oily materials, or turbidity, shall be noted.

2. pH Paper

Use of pH paper is very simple and requires no sample preparation, standardization, etc. pH paper is available in several ranges, including wide-range (indicating approximately pH 1 to 12), mid-range (approximately pH 0 to 6, 6 to 9, 8 to 14) and narrow-range (many available, with ranges as narrow as 1.5 pH units). The appropriate range of pH paper shall be selected. If the pH is unknown the investigation shall start with wide-range paper.

5.2 MEASUREMENT OF SPECIFIC CONDUCTANCE

5.2.1 General

Conductance provides a measure of dissolved ionic species in water and can be used to identify the direction and extent of migration of contaminants in groundwater or surface water. It can also be used as a measure of subsurface biodegradation or to indicate alternate sources of groundwater contamination.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of the ionized substances dissolved in the water and the temperature at which the measurement is made. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

It is important to obtain a specific conductance measurement soon after taking a sample, since temperature changes, precipitation reactions, and absorption of carbon dioxide from the air all affect the specific conductance.

5.2.2 Principles of Equipment Operation

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions migrate toward the negative electrode, while the negatively charged ions migrate toward the positive electrode. Most inorganic acids, bases and salts (such as hydrochloric acid, sodium carbonate, or sodium chloride, respectively) are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not disassociate in aqueous solution, conduct a current very poorly, if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell may also be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

5.2.3 Equipment

The following equipment is needed for taking specific conductance measurements:

- YSI Model 33 portable conductivity, meter, or equivalent
- Probe for above meter

A variety of conductivity meters are available which may also be used to monitor salinity and temperatures. Probe types and cable lengths vary, so equipment may be obtained to meet the specific requirement of the sampling program.

5.2.4 Measurement Techniques for Specific Conductance

The steps involved in taking specific conductance measurements are listed below (standardization is according to manufacturers instructions):

- Check batteries and calibrate instrument before going into the field.
- Calibrate the instrument daily when used. Potassium chloride solutions with a specific-conductance closest to the values expected in the field shall be used. Attachment A may be used for guidance.
- Rinse the cell with one or more portions of the sample to be tested or with deionized water.
- Immerse the electrode in the sample and measure the conductivity. Adjust the temperature setting to the sample temperature.
- Read and record the results in a field logbook or sample log sheet.

If the specific conductance measurements become erratic, or inspection shows that any platinum black has flaked off the electrode, replatinization of the electrode is necessary. See the manufacturer's instructions for details.

Note that specific conductance is occasionally reported at temperatures other than ambient.

5.3 MEASUREMENT OF TEMPERATURE

5.3.1 General

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contaminated groundwater. Temperature measurements shall be taken in-situ, or as quickly as possible in the field. Collected water samples may rapidly equilibrate with the temperature of their surroundings.

5.3.2 Equipment

Temperature measurements may be taken with alcohol-toluene, mercury filled or dial-type thermometers. In addition, various meters such as specific conductance or dissolved oxygen meters, which have temperature measurement capabilities, may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature at great depths can be performed.

5.0 GUIDELINES

5.1 MEASUREMENT OF pH

5.1.1 General

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment such as acid-base neutralization, water softening, and corrosion control, is pH dependent. Likewise, the pH of leachate can be correlated with other chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken.

Measurements of pH can also be used to check the quality and corrosivity of soil and solid waste samples. However, these samples must be immersed in water prior to analysis, and specific techniques are not described.

Two methods are given for pH measurement: the pH meter and pH indicator paper. The indicator paper is used when only a rough estimate of the pH is required, and the pH meter when a more accurate measurement is needed. The response of a pH meter can be affected to a slight degree by high levels of colloidal or suspended solids, but the effect is usually small and generally of little significance. Consequently, specific methods to overcome this interference are not described. The response of pH paper is unaffected by solution interferences from color, turbidity, colloidal or suspended materials unless extremely high levels capable of coating or masking the paper are encountered. In such cases, use of a pH meter is recommended.

5.1.2 Principles of Equipment Operation

Use of pH papers for pH measurement relies on a chemical reaction caused by the acidity or basicity of the solution with the indicator compound on the paper. Depending on the indicator and the pH range of interest, a variety of different colors can be used. Typical indicators are weak acids or bases, or both. Process chemistry and molecular transformations leading to the color change are variable and complex.

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on establishment of a potential difference across a glass or other type of membrane in response to hydrogen ion concentration across that membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to hydrogen ion concentration can be generated and measured.

5.1.3 Equipment

The following equipment is needed for taking pH measurements:

- Accumet 150 portable pH meter, or equivalent.
- Combination electrode with polymer body to fit the above meter (alternately a pH electrode and a reference electrode can be used if the pH meter is equipped with suitable electrode inputs.
- pH indicator paper, such as Hydrion or Alkacid, to cover the pH range 2 through 12.
- Buffer solutions of pH 4, 7 and 10, or other buffers which bracket the expected pH range

5.1.4 Measurement Techniques for Field Determination of pH

1 pH Meter

The following procedure is used for measuring pH with a pH meter (Standardization is according to manufacturers instructions):

a. The instrument and batteries shall be checked and calibrated prior to initiation of the field effort.

b. The accuracy of the buffer solutions used for field and laboratory calibration shall be checked. Buffer solutions need to be changed often due to degradation upon exposure to the atmosphere.

c. Immerse the tip of the electrodes in water overnight. If this is not possible due to field conditions, immerse the electrode tip in water for at least an hour before use. The electrode tip may be immersed in a rubber or plastic sack containing buffer solution for field transport or storage. This is not applicable for all electrodes as some must be stored dry.

d. Make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).

e. Immerse the electrode(s) in a pH-7 buffer solution.

f. Adjust the temperature compensator to the proper temperature (on models with automatic temperature adjustment, immerse the temperature probe into the buffer solution). Alternately, the buffer solution may be immersed in the sample and allowed to reach temperature equilibrium before equipment calibration. It is best to maintain buffer solution at or near expected sample temperature before calibration.

g. Adjust the pH meter to read 7.0.

h. Remove the electrode(s) from the buffer and rinse well with demineralized water. Immerse the electrode(s) in pH-4 or 10 buffer solution (depending on the expected pH of the sample) and adjust the slope control to read the appropriate pH. For best results, the standardization and slope adjustments shall be repeated at least once.

i. Immerse the electrode(s) in the unknown solution, slowly stirring the probe until the pH stabilizes. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a chemical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the logbook.

j. Read and record the pH of the solution, after adjusting the temperature compensator to the sample temperature. pH shall be recorded to the nearest 0.1 pH unit. Also record the sample temperature.

k. Rinse the electrode(s) with deionized water.

l. Keep the electrode(s) immersed in deionized water when not in use.

5.3.3 Measurement Techniques for Water Temperature

If a thermometer is used on a collected water sample:

- Immerse the thermometer in the sample until temperature equilibrium is obtained (1-3 minutes). To avoid the possibility of contamination, the thermometer shall not be inserted into samples which will undergo subsequent chemical analysis.

- Record values in a field logbook or sample log sheet.

If a temperature meter or probe is to be used, the instrument shall be calibrated according to manufacturer's recommendations with an approved thermometer before each measurement or group of closely spaced measurements.

5.4 MEASUREMENT OF DISSOLVED OXYGEN CONCENTRATION

5.4.1 General

Dissolved oxygen (DO) levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. Conversely, the growth of many aquatic organisms as well as the rate of corrosivity, are dependent on the dissolved oxygen concentration. Thus, analysis for dissolved oxygen is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in-situ, since concentration may show a large change in a short time if the sample is not adequately preserved.

The method monitoring discussed herein is limited to the use of dissolved oxygen meters only. Chemical methods of analysis (i.e., Winkler methods) are available, but require more equipment and greater sample manipulation. Furthermore, DO meters, using a membrane electrode, are suitable for highly polluted waters, because the probe is completely submersible, and are free from interference caused by color, turbidity, colloidal material or suspended matter.

5.4.2 Principles of Equipment Operation

Dissolved oxygen probes are normally electrochemical cells that have two solid metal electrodes of different nobility immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of highest nobility (the cathode) is positioned at the membrane. When a suitable potential exists between the two metals, reduction of oxygen to hydroxide ion (OH) occurs at the cathode surface. An electrical current is developed that is directly proportional to the rate of arrival of oxygen molecules at the cathode.

Since the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. It is therefore necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface. To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, but to leave the surface of the solution undisturbed.

Dissolved oxygen probes are relatively free of interferences. Interferences that can occur are reactions with oxidizing gases (such as chlorine) or with gases such as hydrogen sulfide which are not easily depolarized from the indicating electrode. If the gaseous interference is suspected, it shall be noted in the field log book and checked if possible. Temperature variations can also cause interference because probes exhibit temperature sensitivity. Automatic temperature compensation is normally provided by the manufacturer.

5.4.3 Equipment

The following equipment is needed to measure dissolved oxygen concentration:

- YSI Model 56 dissolved oxygen monitor or equivalent.
- Dissolved oxygen/temperature probe for above monitor.
- Sufficient cable to allow the probe to contact the sample.

5.4.4 Measurement Techniques for Dissolved Oxygen Determination

Probes differ as to specifics of use. Follow the manufacturer's instructions to obtain an accurate reading. The following general steps shall be used to measure the dissolved oxygen concentration:

- The equipment shall be calibrated and have its batteries checked in the laboratory before going to the field.

- The probe shall be conditioned in a water sample for as long a period as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.

- The instrument shall be calibrated in the field before each measurement or group of closely spaced measurements by placing the probe in a water sample of known dissolved oxygen concentration (i.e., determined by Winkler method) or in a freshly air-saturated water sample of known temperature. Dissolved oxygen values for air-saturated water can be determined by consulting a table listing oxygen solubilities as a function of temperature and salinity (see Attachment B).

- Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane, either by stirring the sample, or placing the probe in a flowing stream. Probes without stirrers placed in wells can be moved up and down.

- Record the dissolved oxygen content and temperature of the sample in a field logbook or sample log sheet.

- Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer's instructions.

Note that in-situ placement of the probe is preferable, since sample handling is not involved. This however, may not always be practical. Be sure to record whether the liquid was analyzed in-situ, or if a sample was taken.

Special care shall be taken during sample collection to avoid turbulence which can lead to increased oxygen solubilization and positive test interferences.

5.5 MEASUREMENT OF OXIDATION-REDUCTION POTENTIAL

5.5.1 General

The oxidation-reduction potential (ORP) provides a measure of the tendence of organic or inorganic compounds to exist in an oxidized state. The technique therefore provides evidence of the likelihood of anaerobic degradation of biodegradable organics or the ratio of activities of oxidized to reduced species in the sample.

5.5.2 Principles of Equipment Operation

When an inert metal electrode, such as platinum, is immersed in a solution, a potential is developed at that electrode depending on the ions present in the solution. If a reference electrode is placed in the same solution, an ORP electrode pair is established. This electrode pair allows the potential difference between the two electrodes to be measured and will be dependent on the concentration of the ions in solution. By this measurement, the ability to oxidize or reduce species in solution may be determined. Supplemental measurements, such as dissolved oxygen, may be correlated with ORP to provide a knowledge of the quality of the solution, water, or wastewater.

5.5.3 Equipment

The following equipment is needed for measuring the oxidation-reduction potential of a solution:

- Accumet 150 portable pH meter or equivalent, with a millivolt scale.
- Platinum electrode to fit above pH meter.
- Reference electrode such as a calomel, silver-silver chloride, or equivalent.

5.5.4 Measurement Techniques for Oxidation-Reduction Potential

The following procedure is used for measuring oxidation-reduction potential:

- The equipment shall be calibrated and have its batteries checked before going to the field.

- Check that the platinum probe is clean and that the platinum bond or tip is unoxidized. If dirty, polish with emery paper or, if necessary, clean the electrode using aqua regia, nitric acid, or chromic acid, in accordance with manufacturer's instructions.

- Thoroughly rinse the electrode with demineralized water.

- Verify the sensitivity of the electrodes by noting the change in millivolt reading when the pH of the test solution is altered. The ORP will increase when the pH of the test solution decreases and the ORP will decrease if the test solution pH is increased. Place the sample in a clean glass beaker and agitate the sample. Insert the electrodes and note the ORP drops sharply when the caustic is added, the electrodes are sensitive and operating properly. If the ORP increases sharply when the caustic is added, the polarity is reversed and must be corrected in accordance with the manufacturer's instructions. If the ORP does not respond as above when the caustic is added, the electrodes shall be cleaned and the above procedure repeated.

- After the assembly has been checked for sensitivity, wash the electrodes with three changes of water or by means of a flowing stream of water from a wash bottle. Place the sample in a clean glass beaker or sample cup and insert the electrodes. Set temperature compensator throughout the measurement period. Read the millivolt potential of the solution, allowing sufficient time for the system to stabilize and reach temperature equilibrium. Measure successive portions of the sample until readings on two successive portions differ by no more an 10 mV. A system that is very slow to stabilize properly will not yield a meaningful ORP. Record all results in a field logbook, including ORP (to nearest 10 mV), sample temperature and pH at the time of measurement.

5.6 SPECIFIC ION ELECTRODE MEASUREMENTS

5.6.1 General

Use of specific ion electrodes can be beneficial in the field for determining the presence and concentration of dissolved inorganic species which may be associated with contaminant plumes or leachate. Thus, electrodes can be used for rapid screening of water quality and determination of water migration pathways.

This procedure provides generic information for specific ion electrodes commonly used in groundwater quality monitoring programs and describes the essential elements of a field investigation program. Analytical methods using some specific ion electrodes have not been approved by the USEPA. In addition, calibration procedures and solutions, interferences and conditions and requirements for use for various electrodes vary greatly. Consequently, review of manufacturer's literature is mandatory prior to use.

5.6.2 Principles of Equipment Operation

All specific ion electrode measurements involve the use of a reference electrode, a pH meter, and a specific ion electrode (SIE). When the SIE and the reference electrode are immersed in a solution of the ion to be measured, a potential difference is developed between the two electrodes. This potential can be measured by a pH meter and related to the concentration of the ion of interest through the use of standard solutions and calibration curves.

Several different types of SIEs are in use: glass, solid-state, liquid-liquid membrane, and gas-sensing. All of the electrodes function using an ion exchange process as the potential determining mechanism. Glass electrodes are used for pH measurement. The glass in the tip of the electrode actually acts as a semi-permeable membrane to allow solution. Solid-state electrodes replace the glass membrane with an ionically-conducting membrane, (but act in essentially the same manner) while liquid-liquid membrane electrodes have an organic liquid ion exchanger contained in the pores of a hydrophobic membrane. Maintenance of the conducting interface, in combination with a reference electrode, allows completion of the electrical circuit and subsequent measurement of the potential difference. Gas-sensing electrodes have a membrane that permits the passage of gas only, thus allowing for the measurement of gas concentration. Regardless of the mechanism involved in the electrode, most SIEs are easy to use under field conditions. The sensitivity and applicable concentration range for various membranes and electrodes will vary.

5.6.3 Equipment

The following equipment is required for performing quantitative analyses using a specific ion electrode:

- A pH meter with a millivolt scale, or equivalent.
- The specific ion electrode for the parameter to be measured. A partial list of ions which can be measured includes cyanide, sulfide, ammonia, lead, fluoride and chloride.

- A suitable reference electrode to go with the above SIE.

Specific electrodes for other ions have also been developed, but are not widely used for field investigation efforts at this time. Note that of the specific electrodes referenced above, only fluoride and ammonia have analytical methods approved by the USEPA.

5.6.4 Measurement Techniques for Inorganic Ions Using Specific Ion Electrodes

Different types of electrodes are used in slightly different ways and are applicable for different concentration ranges. Following the manufacturer's instructions, the general steps given below are usually followed:

- Immerse the electrode in water for a suitable period of time prior to sample analysis.

- Standardize the electrode according to the manufacturer's instructions, including necessary chemical additions for ionic strength adjustment, etc. Standard solutions normally differ by factors of ten in concentration. Constant stirring is needed for accurate readings.

- Immerse the electrode in the sample. Allow the reading to stabilize and record the results in a site logbook. Stir the sample at the same rate as the standards. Air bubbles near the membrane shall be avoided, since this may cause interference in millivolt readings.

(NOTE: Each SIE has substances which interfere with proper measurement. These may be eliminated using pretreatment methods as detailed by the manufacturer. It is important to know if interferences are present so that suspect readings may be noted as such.)

- If the pH meter does not read out directly, plot millivolts versus concentration for the standards and then determine sample concentration.

6.0 REFERENCES

American Public Health Association, 1980. Standard Methods for the Examination of Water and Wastewater, 15th Edition, APHA, Washington, D.C.

USEPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020.

U.S. Geological Survey, 1984. National Handbook of Recommended Methods for Water Data Acquisition, Chapter 5: Chemical and Physical Quality of Water and Sediment. U.S. Dept. of the Interior, Reston, VA.

Ebasco Services Incorporated; REM III Field Technical Guideline FT-7.10. February 3, 1986.

7.0 RECORDS

Attachment A - Specific Conductance of KC1 Solutions at 25 degrees Centigrade

Attachment B - Variation of Dissolved Oxygen Concentration in Water as a a Function of Temperature and Salinity.

ATTACHMENT A

SPECIFIC CONDUCTANCE OF M KCl AT VARIOUS TEMPERATURES[1]

Temperature (°C)	Specific Conductance (umnos/cm)
15	1,147
16	1,173
17	1,199
18	1,225
19	1,251
20	1,278
21	1,305
22	1,332
23	1,359
24	1,368
25	1,413
26	1,441
27	1,468
28	1,496
29	1,524
30	1,552

1 Data derived from the International Critical Tables 1-3-8.

ATTACHMENT B

VARIATION OF DISSOLVED OXYGEN CONCENTRATION IN WATER AS A FUNCTION OF TEMPERATURE AND SALINITY

Temperature C	Dissolved Oxygen mg/l					
	Chloride Concentration in Water					Difference/100 mg chloride
	0	5,000	10,000	15,000	20,000	
0	14.6	13.8	13.0	12.1	11.3	0.017
1	14.2	13.4	12.6	11.8	11.0	0.016
2	13.8	13.1	12.3	11.5	10.8	0.015
3	13.5	12.7	12.0	11.2	10.5	0.015
4	13.1	12.4	11.7	11.0	10.3	0.014
5	12.8	12.1	11.4	10.7	10.0	0.014
6	12.5	11.8	11.1	10.5	9.8	0.014
7	12.2	11.5	10.9	10.2	9.6	0.013
8	11.9	11.2	10.6	10.0	9.4	0.013
9	11.6	11.0	10.4	9.8	9.2	0.012
10	11.3	10.7	10.1	9.6	9.0	0.012
11	11.1	10.5	9.9	9.4	8.8	0.011
12	10.8	10.3	9.7	9.2	8.6	0.011
13	10.6	10.1	9.5	9.0	8.5	0.011
14	10.4	9.9	9.3	8.8	8.3	0.010
15	10.2	9.7	9.1	8.6	8.1	0.010
16	10.0	9.5	9.0	8.5	8.0	0.010
17	9.7	9.3	8.8	8.3	7.8	0.010
18	9.5	9.1	8.6	8.2	7.7	0.009
19	9.4	8.9	8.5	8.0	7.6	0.009
20	9.2	8.7	8.3	7.9	7.4	0.009
21	9.0	8.6	8.1	7.7	7.3	0.009
22	8.8	8.4	8.0	7.6	7.1	0.008
23	8.7	8.3	7.9	7.4	7.0	0.008
24	8.5	8.1	7.7	7.3	6.9	0.008

ATTACHMENT B

VARIATION OF DISSOLVED OXYGEN CONCENTRATION
IN WATER AS A FUNCTION OF TEMPERATURE AND SALINITY

Temperature C	Dissolved Oxygen mg/l					
	Chloride Concentration in Water					Difference/100 mg chloride
	0	5,000	10,000	15,000	20,000	
25	8.4	8.0	7.6	7.2	6.7	0.008
26	8.2	7.8	7.4	7.0	6.6	0.008
27	8.1	7.7	7.3	6.9	6.5	0.008
28	7.9	7.5	7.1	6.8	6.4	0.008
29	7.8	7.4	7.0	6.6	6.3	0.008
30	7.6	7.3	6.9	6.5	6.1	0.008
31	7.5					
32	7.4					
33	7.3					
34	7.2					
35	7.1					
36	7.0					
37	6.9					
38	6.8					
39	6.7					
40	6.6					
41	6.5					
42	6.4					
43	6.3					
44	6.2					
45	6.1					
46	6.0					
47	5.9					
48	5.8					
49	5.7					
50	5.6					

Note: In a chloride solution, conductivity can be roughly related to chloride concenration (and therefore used to correct measured D.O. concentraiton) using Attachment A.

1.0 PURPOSE

This procedure describes the appropriate containers to be used for samples depending on the analyses to be performed, and the steps necessary to preserve the samples when shipped offsite for chemical analysis.

2.0 SCOPE

Different types of chemicals react differently with sample containers made of various materials. For example, trace metals adsorb more strongly to glass than to plastic, while many organic chemicals may dissolve various types of plastic containers. It is therefore critical to select the correct container in order to maintain the quality of the sample prior to analysis.

Many water and soil samples are unstable, and therefore require preservation when the time interval between field collection and laboratory analysis is long enough to produce changes in either the concentration or the physical condition of the constituent(s) requiring analysis. While complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological changes that inevitably take place after the sample is collected.

Preservation techniques are usually limited to pH control, chemical addition(s) and refrigeration/freezing. Their purpose is to (1) retard biological activity, (2) retard hydrolysis of chemical compounds/complexes, (3) reduce constituent volatility, and (4) reduce adsorption effects.

3.0 GLOSSARY

HCl - Hydrochloric Acid
H_2SO_4 - Sulfuric Acid
HNO_3 - Nitric Acid
$NaOH$ - Sodium Hydroxide

Normality (N) - Concentration of a solution expressed as equivalent per liter, an equivalent being the amount of a substance containing one gram-atom of replaceable hydrogen or its equivalent. Thus, a one molar solution of HCl, containing one gram-atom of H, is "one-normal," while a one molar solution of H_2SO_4 containing two gram-atoms of H, is "two-normal."

4.0 RESPONSIBILITIES

Field Operations Leader - retains overall responsibility for the proper storage and preservation of samples. During the actual collection of samples, the sampling technician(s) will be directly responsible for the bottling, preservation, labeling, and custody of the samples they collect until released to another party for storage or transport to the analytical laboratory.

5.0 PROCEDURES

5.1 SAMPLE CONTAINERS

For most samples and analytical parameters either glass or plastic containers are satisfactory. In general, if the analyte(s) to be determined is organic in nature, the container shall be made of glass. If the analyte(s) is inorganic, then the container shall be plastic. Since container specification will depend on the analyte and sample matrix types (as indicated in Attachment A) duplicate samples shall be taken when both organic and inorganic analyses are required. Containers shall be kept ~

the dark (to minimize biological or photooxidation/photolysis breakdown of constituent) until they reach the analytical laboratory. The sample container shall allow approximately 5-10 percent air space ("ullage") to allow for expansion/vaporization if the sample is heated during transport (1 liter of water at 4°C expands by 15 ml if heated to 130°F/55°C), however, head space for volatile organic analyses shall be omitted.

For CLP laboratories, containers will be obtained through the CLP Sample Management Office. For Responsible party actions or non-CLP laboratories, the laboratory shall provide containers that have been cleaned according to U.S. EPA procedures. Sufficient lead time shall be allowed. Shipping containers for samples, consisting of sturdy ice chests, are provided by the laboratory of the remedial investigation contractor.

Once opened, the container must be used at once for storage of a particular sample. Unused but opened containers are to be considered contaminated and must be discarded; because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused containers which appear contaminated upon receipt, or which are found to have loose caps or missing Teflon liner (if required for the container) shall be discarded.

General sample container and sample volume requirements are listed in Attachment A. Specific container requirements are listed in Attachment B.

5.2 PRESERVATION TECHNIQUES

The preservation techniques to be used for various analytes are listed in Attachments A and B. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the Field or added in the Field. In general, aqueous samples of low concentration organics (or soil samples of low or medium concentration organics) are cooled to 4°C. Medium concentration aqueous samples and high hazard organics sample are not preserved. Low concentration aqueous samples for metals are acidified with HNO_3, while medium concentration and high hazard aqueous metal samples are not preserved. Low or medium concentration soil samples for metals are cooled to 4°C while high hazard samples are not preserved.

The following subsections describe the procedures for preparing and adding chemical preservatives. Attachments A and B indicate the specific analytes which require these preservatives.

5.2.1 Addition of Acid (H_2SO_4, HCl, or HNO_3) or Base

Addition of the following acids or bases may be specified for sample preservation; these reagents shall be analytical reagent (AR) grade and shall be diluted to the required concentration with double-distilled, deionized water in the laboratory, before Field sampling commences:

Acid Base	Concentration	Normality	Amount for Acidification*
HCl	1:1 dilution of concentrated HCl	6N	5-10 ml
H_2SO_4	1:1 dilution of concentrated H_2SO_4	18N	2-5 ml
HNO_3	Undiluted concentrated HNO_3	16N	2-5 ml
NaOH	400 grams solid NaOH in 870 ml water	10N	2 ml**

* Amount of acid to add (at the specified strength) per liter of water to reduce the sample pH to less than 2, assuming that the water is initially at pH 7, and is poorly buffered and does not contain particulate matter.

** To raise pH of 1 liter of water to 12.

The approximate volumes needed to acidify one liter of neutral water to a pH of less than 2 (or raise the pH to 12) are shown in the last column of the above table. These volumes are only approximate; if the water is more alkaline, contains inorganic or organic buffers, or contains suspended particles, more acid may be required. The final pH must be checked using narrow-range pH paper.

Sample acidification or base addition shall proceed as follows:

- Check initial pH of sample with wide range (0-14) pH paper.
- Fill sample bottle to within 5-10 ml of final desired volume and add about 1/2 of estimated acid or base required, stir gently and check pH with medium range pH paper (pH 0-6 or pH 7.5-14, respectively).
- Add acid or base a few drops at a time while stirring gently. Check for final pH using narrow range (0-2.5 or 11-13, respectively) pH paper; when desired pH is reached, cap sample bottle and seal.

  Never dip pH paper into the sample; apply a drop of sample to the pH paper using the stirring rod.

5.2.2 Cyanide Preservation

Pre-sample preservation is required if oxidizing agents such as chlorine are suspected to be present. To test for oxidizing agents, place a drop of the sample on KI-starch paper; a blue color indicates the need for treatment. Add ascorbic acid to the sample, a few crystals at a time, until a drop of sample produces no color on the KI-starch paper. Then add an additional 0.6 g of ascorbic acid for each liter of sample volume. Add NaOH solution to raise pH to greater than 12 as described in 5.2.1 If oxidizing agents are not suspected, add NaOH as directed.

5.2.3 Sulfide Preservation

Samples for sulfide analysis must be preserved by addition of 4 drops (0.2 ml) of 2N zinc acetate solution per 100 ml sample. The sample pH is then raised to 9 using NaOH. The 2N zinc acetate solution is made by dissolving 220 g of zinc acetate in 870 ml of distilled water to make 1 liter of solution.

5.2.4 Preservation of Organic Samples Containing Residual Chlorine

Some organic samples containing residual chlorine must be treated to remove this chlorine upon collection (See Attachment A). Test the samples for residual chlorine using EPA methods 330.4 or 330.5 (Field Test Kits are available for this purpose). If residual chlorine is present, add 0.008% sodium thiosulfate (80 mg per liter of sample).

5.2.5 Field Filtration

When the objective is to determine concentration of dissolved inorganic constituents in a water system, the sample must be filtered through a non-metallic 0.45 micron membrane filter immediately after collection. A filtration system is recommended if large quantities of samples must be filtered in the field. The filtration system shall consist of a Büchner funnel inserted into a single-hole rubber stopper, sized to form a seal when inserted into the top of a vacuum filter flask equipped with a single side arm. Heavy-wall Tygon tubing shall be attached to the single side arm of the vacuum filter flask and the suction port of a vacuum pump. The stem of the Büchner funnel shall extend below the level of the side arm of the vacuum filter flask to prevent any solvent from entering the tubing leading to the vacuum pump. Before filtration, the filter paper, which shall be of a size to lay flat on the funnel plate, shall be wetted with the solvent in order to "seal" it to the funnel. Slowly pour the solvent into the funnel and monitor the amount of solvent entering the vacuum filter flask. When the rate of solvent entering the flask is reduced to intermittent dripping and the added aliquot of solvent in the funnel has passed through the filter, the used filter paper shall be replaced with new filter paper. If the solvent contains a high percentage of suspend solids, a coarser-sized nonmetallic membrane filter may be used prior to usage of the 0.45 mic membrane filter. This "prefiltering" step may be necessary to expedite the filtration procedure. Discard the first 20 to 50 ml of filtrate from each sample to rinse the filter and filtration apparatus to minimize the risk of altering the composition of the samples by the filtering operation. For analysis of dissolved metals, the filtrate is collected in a suitable bottle (see Section 5.1) and is immediately acidified to pH 2.0 or less with nitric acid whose purity is consistent with the measurement to be made. Inorganic anionic constituents may be determined using a portion of the filtrate that has not been acidified.

Samples used for determining temperature, dissolved oxygen, Eh, and pH should not be filtered. Do not use vacuum filtering prior to determining carbonate and bicarbonate concentration because it removes dissolved carbon dioxide and exposes the sample to the atmosphere. Pressure filtration can be done using water pressure from the well. If gas pressure is required, use an inert gas such as argon or nitrogen.

Do not filter samples for analysis of volatile organic compounds. If samples are to be filtered for analyzing other dissolved organic constituents, use a glass-fiber or metal-membrane filter and collect the samples in a suitable container (see Section 5.1). Because most organic analyses require extraction of the entire sample, do not discard any of it. After filtering, the membrane containing the suspended fraction can be sealed in a glass container and analyzed separately as soon as practicable. Total recoverable inorganic constituents may be determined using a second, unfiltered sample collected at the same time as the sample for dissolved constituents.

6.0 REFERENCES

American Public Health Association, 1981. Standard Methods for the Examination of Water and Wastewater. 15th Edition. APHA, Washington, D.C.

USEPA, 1984 "Guidelines Establishing Test Procedures for the Analysis of Pollutants under Clean Water Act." Federal Register, Volume 49 (209), October 26, 1984, p. 43234.

USEPA, 1979 Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020. USEPA-EMSL, Cincinnati, Ohio.

Ebasco Services Incorporated; REM III Field Technical Guideline No. FT-7.06. March 4, 1986.

7.0 ATTACHMENTS

Attachment A - General Sample Container and Preservation Requirements CERCLA/RCRA Samples
Attachment B - Required Containers, Preservation Techniques, and Holding Times (3 sheets)

	SAMPLE TYPE & CONCENTRATION	CONTAINER[1]	SAMPLE SIZE	PRESERVATION[2]	HOLDING TIME[2]
WATER					
Organics (GC & GC/MS)	VOA	borosilicate glass	2 x 40 ml	Cool to 4°C	7 days
	Extractables Low	amber glass	2 x 2 l or 4 x 1 l	Cool to 4°C	5 days to extraction 40 days after extraction
	Medium	wide-mouth glass	4 x 32 oz	None	Same as above
Inorganics	Metals Low	high density (h.d.) polyethylene	1 l	HNO_3 to pH ≤2	6 months (Hg-30 days)
	Medium	wide-mouth glass	16 oz	None	6 months
	Cyanide Low	h.d. polyethylene	1 l	NaOH to pH >12	14 days
	Medium	wide-mouth glass	16 oz	None	
Organic/Inorganic	High Hazard	8 oz wide-mouth glass	6 oz	None	14 days
COD	--	h.d. polyethylene	0.5 l	H_2SO_4 to pH <2	28 days
TOC	--	h.d. polyethylene	0.5 l	HCl to pH <2	28 days
Oil & Grease	--	glass	1.0 l	H_2SO_4 to pH <2	28 days
Phenols	--	h.d. polyethylene	1.0 l	H_2SO_4 to pH <2	28 days
General Chemistry	--	h.d. polyethylene	1.0 l	None	---
SOIL					
Organics (GC & GC/MS)	VOA	2 x 120 ml (4 oz) wide-mouth glass	240 ml	Cool to 4°C	10 days
	Extractables Low/Medium	8 oz or 2 x 4 oz (120 ml) wide-mouth glass	6 oz	Cool to 4°C	10 days to extraction 40 days after extraction
Inorganics	Low/Medium	8 oz or 2 x 4 oz (120 ml) wide-mouth glass	6 oz	Cool to 4°C	NA
Organic/Inorganic	High Hazard	8 oz (120 ml) wide-mouth glass	6 oz	None	NA
Dioxin	All	4 oz (120 ml) wide-mouth glass	4 oz	None	NA
EP Toxicity	All	250 ml h.d. polyethylene	200 grams	None	NA
Air					
Volatile Organics	Low Medium	Charcoal Tube 7 cm long, 6 mm OD, 4 mm ID	100 l air	Cool to 4°C	NA

1. All glass containers should have Teflon cap liners or septa.
2. See Attachment B.

SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS CERCLA/RCRA SAMPLES

SAMPLE PRESERVATION

CP-00402-3.05-10/1/90

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ATTACHMENT B

REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

PAGE 1

Parameter No./Name	Container[1]	Preservation[2,3]	Maximum Holding Time[4]
INORGANIC TESTS:			
Acidity	P,G	Cool, 4°C	14 days
Alkalinity	P,G	Cool, 4°C	14 days
Ammonia	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Biochemical Oxygen Demand	P,G	Cool, 4°C	48 hours
Bromide	P,G	None required	28 days
Biochemical Oxygen Demand, Carbonaceous	P,G	Cool, 4°C	48 hours
Chemical Oxygen Demand	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Chloride	P,G	None required	28 days
Chlorine, Total Residual	P,G	None required	Analyze immediately
Color	P,G	Cool, 4°C	48 hours
Cyanide, Total and Amenable to Chlorination	P,G	Cool, 4°C, NaOH to pH 12, 0.6g ascorbic acid[5]	14 days[6]
Fluoride	P	None required	28 days
Hardness	P,G	HNO_3 to pH 2, H_2SO_4 to pH 2	6 months
Hydrogen Ion (pH)	P,G	None required	Analyze immediately
Kjeldahl and Organic Nitrogen	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Nitrate	P,G	Cool, 4°C	48 hours
Nitrate-Nitrite	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Nitrite	P,G	Cool, 4°C	48 hours
Oil and Grease	G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Organic Carbon	P,G	Cool, 4°C, HCl or H_2SO_4 to pH 2	28 days
Orthophosphate	P,G	Filter immediately, Cool, 4°C	48 hours
Oxygen, Dissolved-Probe	G Bottle and top	None required	Analyze immediately
Oxygen, Dissolved-Winkler	G Bottle and top	Fix on site and store in dark	8 hours
Phenols	G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Phosphorus (elemental)	G	Cool, 4°C	48 hours
Phosphorus, Total	P,G	Cool, 4°C, H_2SO_4 to pH 2	28 days
Residue, Total	P,G	Cool, 4°C	7 days
Residue, Filterable	P,G	Cool, 4°C	48 hours
Residue, Nonfilterable (TSS)	P,G	Cool, 4°C	7 days
Residue, Settleable	P,G	Cool, 4°C	48 hours
Residue, Volatile	P,G	Cool, 4°C	7 days
Silica	P	Cool, 4°C	28 days
Specific Conductance	P,G	Cool, 4°C	28 days
Sulfate	P,G	Cool, 4°C	28 days
Sulfide	P,G	Cool, 4°C, add zinc acetate plus sodium hydroxide to pH 9	7 days
Sulfite	P,G	None required	Analyze immediately
Surfactants	P,G	Cool, 4°C	48 hours
Temperature	P,G	None required	Analyze immediately
Turbidity	P,G	Cool, 4°C	48 hours
METALS:[7]			
Chromium VI	P,G	Cool, 4°C	24 hours
Mercury	P,G	HNO_3 to pH 2	28 days
Metals, except Chromium VI and Mercury	P,G	HNO_3 to pH 2	6 months

Parameter No./Name	Container[1]	Preservation[2,3]	Maximum Holding Time[4]
ORGANIC TESTS:[8]			
Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	14 days
Purgeable Aromatic Hydrocarbons	G, Teflon-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$[5] HCl to pH 2[9]	14 days
Acrolein and Acrylonitrile	G, Teflon-lined septum	Cool, 4°C, 0.008% $Na_2S_2O_3$[5] adjust pH to 4-5[10]	14 days
Phenols[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction, 40 days after extraction
Benzidines[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction[13]
Phthalate Esters[11]	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 40 days after extraction
Nitrosamines[11,14]	G, Teflon-lined cap	Cool, 4°C, store in dark, 0.008% $Na_2S_2O_3$[5]	7 days until extraction, 40 days after extraction
PCBs[11] Acrylonitrile	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 40 days after extraction
Nitroaromatics and Isophorone[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5], store in dark	7 days until extraction, 40 days after extraction
Poly..clear Aromatic Hydrocarbons[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5], store in dark	7 days until extraction, 40 days after extraction
Haloethers[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction, 40 days after extraction
Chlorinated Hydrocarbons[11]	G, Teflon-lined cap	Cool, 4°C	7 days until extraction, 40 days after extraction
TCDD[11]	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$[5]	7 days until extraction, 40 days after extraction
PESTICIDES TESTS:			
Pesticides[11]	G, Teflon-lined cap	Cool, 4°C, pH 5-9[15]	7 days until extraction, 40 days after extraction
RADIOLOGICAL TESTS:			
1-5 Alpha, beta and radium	P, G	HNO_3 to pH 2	6 months

TABLE 1 Notes

(1) Polyethylene (P) or Glass (G).

(2) Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the ime of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at .° until compositing and sample splitting is completed.

(3) When any sample is to be shipped by common carrier or sent through the United States Mails, it must comply with the Department of Transportation ardous Materials Regulations (49 CFR Part 172).

(4) Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis 1 still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the .ic types of samples under study are stable for the longer time, and has received a variance from the Regional Administrator.

(5) Should only be used in the presence of residual chlorine.

(6) Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

(7) Samples should be filtered immediately on-site before adding preservative for dissolved metals.

(8) Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

(9) Sample receiving no pH adjustment must be analyzed within seven days of sampling.

(10) The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.

(11) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for seven days before extraction and for forty days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re: the requirement for thiosulfate reduction of residual chlorine) and footnotes 12, 13 (re: the analysis of benzidine).

(12) If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.

(13) Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.

(14) For the analysis of diphenylnitrosamine add 0.008% $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.

(15) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

1.0 PURPOSE

The purpose of these procedures is to provide a general methodology, protocol, and reference information on the proper decontamination procedures to be used on chemical sampling and field analytical equipment.

2.0 SCOPE

This procedure addresses chemical sampling and field analytical equipment only, and should be consulted when equipment decontamination procedures are being developed as part of project-specific plans.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Site Manager - responsible for ensuring that project-specific plans and the implementation of field investigations are in compliance with these guidelines.

Field Operations Leader - responsible for ensuring that decontamination procedures for all chemical sampling and field analytical equipment are programmed prior to the actual field effort and that personnel required to accomplish the task have been briefed and trained to execute the task.

5.0 PROCEDURES

In order to assure that chemical analysis results are reflective of the actual concentrations present at sampling locations, chemical sampling and field analysis equipment must be properly decontaminated prior to the field effort, during the sampling program (i.e., between sample points) and at the conclusion of the sampling program. This will minimize the potential for cross-contamination between sample points and the transfer of contamination offsite.

This procedure incorporates only those aspects of decontamination not addressed in other procedures. Specifically it incorporates those items involved in decontamination of chemical sampling and field analytical equipment.

5.1 ACCESS FOR SAMPLING

Bailers and Bailing Line

The potential for cross-contamination between sampling points via the use of common bailer, or its attached line, is high unless strict procedures for decontamination are followed. It is preferable, for the aforementioned reason, to dedicate an individual bailer and its line to each sample point, although this does not eliminate the need for decontamination of dedicated bailers. For non-dedicated sampling equipment, the following conditions and/or decontamination procedures should be followed.

Before the initial sampling and after each succeeding sampling point, the bailer must be decontaminated. The following steps should be followed:

- Potable water rinse
- Alconox or Liquinox detergent wash
- Scrubbing of the line and bailer with a scrub brush may be required if the sample point if heavily contaminated with heavy or extremely viscous compounds
- Potable water rinse
- Rinse with 10 percent nitric acid solution*
- Distilled deionized water rinse
- acetone or methanol rinse
- Distilled/deionized water rinse
- Air dry

Braided nylon or polypropylene lines may be used with a bailer, however, the same line must not come in contact with the sample medium, otherwise, the line must be discarded in an approved receptacle and replaced. Prior to use, the bailer should be wrapped in aluminum foil or polyethylene sheeting.

Sampling Pumps

Most sampling pumps are normally low volume (less than 2 gpm) pumps. These include peristaltic, diaphragm, air-lift, pitcher and bladder pumps, to name a few. If these pumps are used for sampling from more than one sampling point, they must be decontaminated.

The procedures to be used for decontamination of sampling pumps compare to those used for a bailer except the 10 percent nitric acid solution is omitted. Each of the liquid factions is to b pumped through the system. The amount of pumping is dependent upon the size of the pump ar the length of the intake and discharge hoses. Certain types of pumps are unacceptable for sampling purposes.

An additional problem is introduced when the pump relies on extraction of water via an inlet or outlet hose. For organic sampling, this hose should be Teflon. Other types of hoses leach organics into the water being sampled (especially the phthalate esters) or adsorb organics from the sampled water. For all other sampling, the hose should be Viton, polyethylene, or polyvinyl chloride (in order of preference).

Filtering Equipment

Part of the sampling plan may incorporate the filtering of groundwater samples, and subsequent preservation. This should occur as soon after sample retrieval as possible; preferably in the field as soon as the sample is obtained. To this end, three basic filtration systems are most commonly used - the in-line disposable Teflon filter, the inert gas over-pressure filtration system, and the vacuum filtration system.

For the in-line filter, decontamination is not required since the filter cartridge is disposable, however, the cartridge must be disposed of in an approved receptacle and the intake and discharge lines must still be decontaminated.

* Due to the leaching ability of nitric acid, on stainless steel, this step is to be omitted if a stainless steel sampling device is being used and metals analysis is required with detection limits less than approximately 50 ppb; or the sampling equipment is dedicated.

For the over-pressure and the vacuum filtration systems, the portions of the apparatus which come in contact with the sample must be decontaminated. (Note: Varieties of both of these systems come equipped from the manufacturer with Teflon-lined surfaces for those that would come into contact with the sample. These filtration systems are preferred when decontamination procedures must be employed.)

5.2 FIELD ANALYTICAL EQUIPMENT

<u>Water Level Indicators</u>

Water level indicators that consist of a probe that contacts with the groundwater must be decontaminated using the following steps:

- Rinse with tapwater
- Rinse with deionized water
- Acetone or methanol rinse
- Rinse with deionized water

Water level indicators that do not come in contact with the groundwater but may encounter incidental contact during installation or retrieval need only undergo the first and last steps stated above.

<u>Probes</u>

Probes, e.g., pH or specific ion electrodes, geophysical probes, or thermometers which would come in direct contact with the sample, will be decontaminated using the procedures specified above unless manufacturer's instructions indicate otherwise; in those cases, the methods of decontamination must be clearly described in the FSAP. For probes which make no direct contact, e.g., OVA equipment, the probe will be wiped with clean paper-towels or cloth wetted with alcohol.

6.0 REFERENCES

Ebasco Services Incorporated; REM III Field Technical Guideline No. FT-12.01. June 22, 1986.

7.0 RECORDS

None

1.0 PURPOSE

The purpose of this document is to establish standard procedures and technical guidance on borehole and sample logging.

2.0 SCOPE

These procedures provide descriptions of the standard techniques for borehole and sample logging. These techniques shall be used for each boring logged to provide consistent descriptions of subsurface lithology. While experience is the only method to develop confidence and accuracy in the description of soil and rock, the field geologist/engineer can do a good job of classification by careful, thoughtful observation and by being consistent throughout the classification procedure.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Site Geologist - Responsible for supervising all boring activities and assuring that each borehole is completely logged. If more than one rig is being used onsite the Site Geologist must make sure that each rig geologist is properly trained in logging procedures. A brief review or training session may be necessary prior to the start up of the field program and/or upon completion of the first boring.

5.0 PROCEDURES

The classification of soil and rocks is one of the most important jobs of the field geologist/engineer. To maintain a consistent flow of information, it is imperative that the field geologist/engineer understand and accurately use the field classification system described in this SOP. This identification is based on visual examination and manual tests.

5.1 MATERIALS NEEDED

When logging soil and rock samples, the geologist or engineer shall be equipped with the following:

- Rock hammer
- Knife
- Camera
- Dilute HCl
- Brunton compass
- Ruler (marked in tenths and hundreths of feet)
- Hand Lens

5.2 CLASSIFICATION OF SOILS

All data shall be written directly on the boring log (Exhibit 4-1) or in a field notebook if more space is needed. Details on filling out the boring log are discussed in Section 5.5.

5.2.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Exhibit 4-2. This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse grained soils shall be divided into rock fragments, sand, or gravel. The terms and sand and gravel not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term rock fragments shall be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges typically observed indicate little or no transport from their source area, and therefore the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used it shall be followed by a size designation such as (1/4 inchΦ-1/2 inchΦ)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

5.2.2 Color

Soil colors shall be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray". Since color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Soil samples shall be broken or split vertically to describe colors. Samplers tend to smear the sample surface creating color variations between the sample interior and exterior.

The term "mottled" shall be used to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

Soil Color Charts shall not be used unless specified by the project manager.

5.2.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are noncohesive (particles do not adhere well when compressed). Finer grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

The density of noncohesive, granular soils is classified according to standard penetration resistances obtained from split barrel sampling performed according to the methods detailed in Standard Operating Procedures GH-1.3 and S[illegible]-1.2. Those designations are:

Designation	Standard Penetration Resistance (Blows per Foot)
Very loose	0 to 4
Loose	5 to 10
Medium dense	11 to 30
Dense	31 to 50
Very dense	Over 50

Standard penetration resistance is the number of blows required to drive a split-barrel sampler with a 2-inch outside diameter 12 inches into the material using a 140 pound hammer falling freely through 30 inches. The sampler is driven through an 18-inch sample interval, and the number of blows is recorded for each 6-inch increment. The density designation of granular soils is obtained by adding the number of blows required to penetrate the last 12 inches of each sample interval. It is important to note that if gravel or rock fragments are broken by the sampler or if rock fragments are lodged in the tip, the resulting blow count will be erroneously high, reflecting a higher density than actually exists. This shall be noted on the log and referenced to the sample number. Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, and SC (see Exhibit 4-2).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in Exhibit 4-3. Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Exhibit 4-2).

The consistency of cohesive soils is determined either by blow counts, a pocket penetrometer (values listed in the table as Unconfined Compressive Strength) or by hand by determining the resistance to penetration by the thumb. The pocket penetrometer and thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample in the split-barrel sampler. The sample shall be broken in half and the thumb or penetrometer pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. Consistency shall not be determined solely by blow counts. One of the other methods shall be used in conjunction with it. The designations used to describe the consistency of cohesive soils are as follows:

Consistency	Unc. Compressive Str. Tons/Square Foot	Standard Penetration Resistance (Blows per Foot)	Field Identification Methods
Very soft	Less than 0.25	0 to 2	Easily penetrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb
Medium stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb
Very stiff	1.0 to 2.0	8 to 15	Readily indented by thumb
Hard	2.0 to 4.0	15 to 30	Readily indented by thumbnail
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail

5.2.4 Weight Percentages

In nature, soils are comprised of particles of varying size and shape, and are combinations of the various grain types. The following terms are useful in the description of soil:

Terms of Identifying Proportion of the Component	Defining Range of Percentages by Weight
trace	0 - 10 percent
some	11 - 30 percent
and or adjective form of the soil type (e.g., "sandy")	31 - 50 percent

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

5.2.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested parameter for this would be calling a soil wet if rolling it in the hand or on a porous surface liberates water, i.e., dirties or muddies the surface. Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job.

Laboratory tests for water content shall be performed if the natural water content is important.

5.2.6 Stratification

Stratification can only be determined after the sample barrel is opened. The stratification or bedding thickness for soil and rock is depending on grain size and composition. The classification to be used for stratification description is shown in Exhibit 4-4.

5.2.7 Texture/Fabric/Bedding

The texture/fabric/bedding of the soil shall be described. Texture is described as the relative angularity of the particles: rounded, subrounded, subangular, and angular. Fabric shall be noted as to whether the particles are flat or bulky and whether there is a particular relation between particles (i.e., all the flat particles are parallel or there is some cementation). The bedding or structure shall also be noted (e.g., stratified, lensed, nonstratified, heterogeneous varved).

5.2.8 Summary of Soil Classification

In summary, soils shall be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (Optional)
- Soil types
- Moisture content
- Stratification
- Texture, fabric, bedding
- Other distinguishing features

5.3 CLASSIFICATION OF ROCKS

Rocks are grouped into three main divisions, including sedimentary, igneous and metamorphic rocks. Sedimentary rocks are by far the predominant type exposed at the earth's surface. The following basic names are applied to the types of rocks found in sedimentary sequences:

- Sandstone - Made up predominantly of granular materials ranging between 1/16 and 2 inch in diameter.

- Siltstone - Made up of granular materials less than 1/16 inch in diameter. Fractures irregularly. Medium thick to thick bedded.

- Claystone - Vary fine grained rock made up of clay and silt-size materials. Fractures irregularly. Very smooth to touch. Generally has irregularly spaced pitting on surface of drilled cores.

- Shale - A fissile very fine grained rock. Fractures along bedding planes.

- Limestone - Rock made up predominantly of calcite ($CaCO_3$). Effervesces strongly upon the application of dilute hydrochloric acid.

- Coal - Rock consisting mainly of organic remains.

- Others - Numerous other sedimentary rock types are present in lesser amounts in the stratigraphic record. The local abundance of any of these rock types is dependent upon the depositional history of the area. These include conglomerate, halite, gypsum, dolomite, anhydrite, lignite, etc. are some of the rock types found in lesser amounts.

In classifying a sedimentary rock the following hierarchy shall be noted:

- Rock type
- Color
- Bedding thickness
- Hardness
- Fracturing
- Weathering
- Other characteristics

5.3.1 Rock Type

As described above, there are numerous names of sedimentary rocks. In most cases a rock will be a combination of several grain types, therefore, a modifier such as a sandy siltstone, or a silty sandstone can be used. The modifier indicates that a significant portion of the rock type is composed of the modifier. Other modifiers can include carbonaceous, calcareous, siliceous, etc.

Grain size is the basis for the classification of clastic sedimentary rocks. Exhibit 4-5 is the Udden-Wentworth classification that will be assigned to sedimentary rocks. The individual boundaries are slightly different than the USCS subdivision for soil classification. For field determination of grain sizes, a scale can be used for the coarse grained rocks. For example, the division between siltstone and claystone may not be measurable in the field. The boundary shall be determined by use of a hand lens. If the grains cannot be seen with the naked eye but are distinguishable with a handlens, the rock is a siltstone. If the grains are not distinguishable with a handlens, the rock is a claystone.

5.3.2 Color

The color of a rock can be determined in a similar manner as for soil samples. Rock core samples shall be classified while wet, when possible, and air cored samples shall be scraped clean of cuttings prior to color classifications.

Rock Color Charts shall not be used unless specified by the project manager.

5.3.3 Bedding Thickness

The bedding thickness designations applied to soil classification will also be used for rock classification.

5.3.4 Hardness

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness is as follows:

- Soft - Weathered, considerable erosion of core, easily gouged by screwdriver, scratched by fingernail. Soft rock crushes or deforms under pressure of a pressed hammer. This term is always used for the hardness of the saprolite (decomposed rock which occupies the zone between the lowest soil horizon and firm bedrock).

- Medium soft - Slight erosion of core, slightly gouged by screwdriver, or breaks with crumbly edges from single hammer blow.

- Medium hard - No core erosion, easily scratched by screwdriver, or breaks with sharp edges from single hammer blow.

- Hard - Requires several hammer blows to break and has sharp conchoidal breaks. Cannot be scratched with screwdriver.

Note the difference in usage here of the works "scratch" and "gouge". A scratch shall be considered a slight depression in the rock (do not mistake the scraping off of rock flour from drilling with a scratch in the rock itself), while a gouge is much deeper.

5.3.5 Fracturing

The degree of fracturing or brokeness of a rock is described by measuring the fractures or joint spacing. After eliminating drilling breaks, the average spacing is calculated and the fracturing is described by the following terms:

- Very broken (V. BR.) - Less than 2 in. spacing between fractures
- Broken (BR.) - 2 in. to 1 ft. spacing between fractures
- Blocky (BL.) - 1 to 3 ft. spacing between fractures
- Massive (M.) - 3 to 10 ft. spacing between fractures

The structural integrity of the rock can be approximated by calculating the Rock Quality Designation (RQD) of cores recovered. The RQD is determined by adding the total lengths of all pieces exceeding 4 inches and dividing by the total length of the coring run, to obtain a percentage.

Method of Calculating RQD
(After Deere, 1964)

RQD % = $r/l \times 100$

r = Total length of all pieces of the lithologic unit being measured, which are greater than 4 inches length, and have resulted from natural breaks. Natural breaks include slickensides, joints, compaction slicks, bedding plane partings (not caused by drilling), friable zones, etc.

l = Total length of the coring run.

5.3.6 Weathering

The degree of weathering is a significant parameter that is important in determining weathering profiles and is also useful in engineering designs. The following terms can be applied to distinguish the degree of weathering:

- Fresh - Rock shows little or no weathering effect. Fractures or joints have little or no staining and rock has a bright appearance.

- Slight - Rock has some staining which may penetrate several centimeters into the rock. Clay filling of joints may occur. Feldspar grains may show some alteration.

- Moderate - Most of the rock, with exception of quartz grains, is stained. Rock is weakened due to weathering and can be easily broken with hammer.

- Severe - All rock including quartz grains is stained. Some of the rock is weathered to the extent of becoming a soil. Rock is very weak.

5.3.7 Other Characteristics

The following items shall be included in the rock description:

- Description of contact between two rock units. These can be sharp or gradational.
- Stratification (parallel, cross stratified)
- Description of any filled cavities or vugs.
- Cementation (calcoreous, siliceous, hematitic)

- Description of any joints or open fractures.
- Observation of the presence of fossils.
- Notation of joints with depth, approximate angle to horizontal, any mineral filling or coating, and degree of weathering.

All information shown on the boring logs shall be neat to the point where it can be reproduced on a copy machine for report presentation. The data shall be kept current to provide control of the drilling program and to indicate various areas requiring special consideration and sampling.

5.3.8 Additional Terms Used in the Description of Rock

The following terms are used to further identify rocks:

- Seam - Thin (12 inch or less), probably continuous layer.

- Some - Indicates significant (15 to 40 percent) amounts of the accessory material. For example, rock composed of seams of sandstone (70 percent) and shale (30 percent) would be "sandstone -- some shale seams."

- Few - Indicates insignificant (0 to 15 percent) amounts of the accessory material. For example, rock composed of seam of sandstone (90 percent) and shale (10 percent) would be "sandstone -- few shale seams."

- Interbedded - Used to indicate thin or very thin alternating seams of material occurring in approximately equal amounts. For example, rock composed of thin alternating seams sandstone (50 percent) and shale (50 percent) would be "interbedded sandstone and shale."

- Interlayered - Used to indicate thick alternating seams of material occurring in approximately equal amounts.

The preceding sections describe the classification of sedimentary rocks. The following are some basic names that are applied to igneous rocks:

- Basalt - A fine-grained extrusive rock composed primarily of calcic plagioclase and pyroxene.

- Rhyolite - A fine-grained volcanic rock containing abundant quartz and orthoclase. The fine-grained equivalent of a granite.

- Granite - A coarse-grained plutonic rock consisting essentially of alkali feldspar and quartz.

- Diorite - A coarse-grained plutonic rock consisting essentially of sodic plagioclase and hornblende.

- Gabbro - A coarse-grained plutonic rock consisting of calcic plagioclase and clinopyroxene. Loosely used for any coarse grained dark igneous rock.

The following are some basic names that are applied to metamorphic rocks:

- Slate - A very fine-grained foliated rock possessing a well developed slaty cleavage Contains predominantly chlorite, mica, quartz, and sericite.

- Phyllite - A fine-grained foliated rock that splits into thin flaky sheets with a silky sheen on cleavage surface.

- Schist - A medium to coarse-grained foliated rock with subparallel arrangement of the micaceous minerals which dominate its composition.

- Gneiss - A coarse-grained foliated rock with bands rich in granular and platy minerals.

- Quartzite - A fine to coarse-grained nonfoliated rock breaking across grains, consisting essentially of quartz sand with silica cement.

5.4 ABBREVIATIONS

Abbreviations may be used in the description of a rock or soil. However, they shall be kept at a minimum. Following are some of the abbreviations that may be used:

C - Coarse	Lt - Light	Yl - Yellow
Med - Medium	BR - Broken	Or - Orange
F - Fine	BL - Blocky	SS - Sandstone
V - Very	M - Massive	Sh - Shale
Sl - Slight	Br - Brown	LS - Limestone
Occ - Occasional	Bl - Black	Fgr - Fine grained
Tr - Trace		

5.5 BORING LOGS AND DOCUMENTATION

This section describes in more detail the procedures to be used in completing boring logs in the field. Information obtained from the preceeding sections shall be used to complete the logs. A sample boring log has been provided as Exhibit 4-6. The field geologist/engineer shall use this example as a guide in completing each borings log. Each boring log shall be fully described by the geologist/engineer as the boring is being drilled. Every sheet contains space for 25 feet of log. Information regarding classification details is provided on the back of the boring log, for field use.

5.5.1 Soil Classification

- Identify site name, boring number, job number, etc. Elevations and water level data to be entered when surveyed data is available.

- Enter sample number (from SPT) under appropriate column. Enter depth sample was taken from (1 block = 1 foot). Fractional footages, i.e., change of lithology a 13.7 feet, shall be lined off at the proportional location between the 13 and 14 foot marks. Enter blow counts (Standard Penetration Resistance) diagonally (as shown). Standard penetration resistance is covered in Section 5.2.3.

- Determine sample recovery/sample length as shown. Measure the total length of sample recovered from the split spoon sampler, including material in the drive shoe. Do not include cuttings or wash material that may be in the upper portion of the sample tube.

- Indicate any change in lithology by drawing a line at the appropriate depth. For example, if clayey silt was encountered from 0 to 5.5 feet and shale from 5.5 to 6.0 feet, a line shall be drawn at this increment. This information is helpful in the construction of cross-sections. As an alternative, symbols may be used to identify each change in lithology.

- The density of granular soils is obtained by adding the number of blows for the last two increments. Refer to Density of Granular Soils Chart of back of log sheet. For consistency of cohesive soils refer also to the back of log sheet - Consistency of Cohesive Soils. Enter this information under the appropriate column. Refer to Section 5.2.3.

- Enter color of the material in the appropriate column.

- Describe material using the USCS. Limit this column for sample description only. The predominate material is described last. If the primary soil is silt but has fines (clay) - use clayey silt. Limit soil descriptors to the following:

  - Trace 0 - 10 percent
  - Some 11 - 30 percent
  - And 31 - 50 percent

- Also indicate under Material Classification if the material is fill or natural soils. Indicate roots, organic material, etc.

- Enter USCS symbol - use chart on back of boring log as a guide. If the soils fall into one of two basic groups, a borderline symbol may be used with the two symbols separated by a slash. For example ML/CL or SM/SP.

- The following information shall be entered under the Remarks Column and shall include, but is not limited by the following:

  - Moisture - estimate moisture content using the following terms - dry, moist, wet and saturated. These terms are determined by the individual. Whatever method is used to determine moisture, be consistent throughout the log.

  - Angularity - describe angularity of coarse grained particles using Angular, Subangular, Subrounded, Rounded. Refer to ASTM D 2488 or Earth Manual for criteria for these terms.

  - Particle shape - flat, elongated, or flat and elongated.

  - Maximum particle size or dimension.

  - Water level observations.

  - Reaction with HCl - none, weak or strong.

- Additional comments:
  - Indicate presence of mica, caving of hole, when water was encountered, difficulty in drilling, loss or gain of water.
  - Indicate odor and HNu or OVA reading if applicable.
  - Indicate any change in lithology by drawing in line through the lithology change column and indicate the depth. This will help later on when cross-sections are constructed.
  - At the bottom of the page indicate type of rig, drilling method, hammer size and drop and any other useful information (i.e., borehole size, casing set, changes in drilling method).
  - Vertical lines shall be drawn (as shown in Exhibit 4.6) in columns 5 to 8 from the bottom of each sample to the top of the next sample to indicate consistency of material from sample to sample, if the material is consistent. Horizontal lines shall be drawn if there is a change in lithology, then vertical lines drawn to that point.
  - Indicate screened interval of well, as needed, in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.5.2 <u>Rock Classification</u>

- Indicate depth at which coring began by drawing a line at the appropriate depth. Indicate core run depths by drawing coring run lines (as shown) under the first and fourth columns on the log sheet. Indicate RQD, core run number, RQD percent and core recovery under the appropriate columns.
- Indicate lithology change by drawing a line at the appropriate depth as explained in Section 5.5.1.
- Rock hardness is entered under designated column using terms as described on the back of the log or as explained earlier in this section.
- Enter color as determined while the core sample is wet; if the sample is cored by air, the core shall be scraped clean prior to describing color.

  Enter rock type based on sedimentary, igneous or metamorphic. For sedimentary rocks use terms as described in Section 5.3. Again, be consistent in classification. Use modifiers and additional terms as needed. For igneous and metamorphic rock types use terms as described in Sections 5.3.8.
- Enter brokeness of rock or degree of fracturing under the appropriate column using symbols VBR, BR, BL, or M as explained in Section 5.3.5 and as noted on the back of the Boring Log.

- The following information shall be entered under the remarks column. Items shall include but are not limited to the following:
  - Indicate depths of joints, fractures and breaks and also approximate to horizontal angle (such as high, low), i.e., 70° angle from horizontal, high angle.
  - Indicate calcareous zones, description of any cavities or vugs.
  - Indicate any loss or gain of drill water.
  - Indicate drop of drill tools or change in color of drill water.

- Remarks at the bottom of Boring Log shall include:
  - Type and size of core obtained.
  - Depth casing was set.
  - Type of Rig used.

- As a final check the boring log shall include the following:
  - Vertical lines shall be drawn as explained for soil classification to indicate consistency of bedrock material.
  - If applicable, indicate screened interval in the lithology column. Show top and bottom of screen. Other details of well construction are provided on the well construction forms.

5.5.3 Classification of Soil and Rock from Drill Cuttings

The previous sections describe procedures for classifying soil and rock samples when cores are obtained. However, some drilling methods (air/mud rotary) may require classification and borehole logging based on identifying drill cuttings removed from the borehole. Such cuttings provide only general information on subsurface lithology. Some procedures that shall be followed when logging cuttings are:

- Obtain cutting samples at approximately 5 foot intervals, sieve the cuttings (if mud rotary drilling) to obtain a cleaner sample, place the sample into a small sample bottle or "zip lock" bag for future reference, and label the jar or bag (i.e. hole number, depth, date etc.). Cuttings shall be closely examined to determine general lithology.

- Note any change in color of drilling fluid or cuttings, to estimate changes in lithology.

- Note drop or chattering of drilling tools or a change in the rate of drilling, to determine fracture locations or lithologic changes.

- Observe loss or gain of drilling fluids or air (if air rotary methods are used), to identify potential fracture zones.

- Record this and any other useful information onto the boring log as provided in Exhibit 4-1.

This logging provides a general description of subsurface lithology and adequate information can be obtained through careful observation of the drilling process. It is recommended that split barrel and rock core sampling methods be used at selected boring locations during the field investigation to provide detailed information to supplement the less detailed data generated through borings drilled using air/mud rotary methods.

5.6 REVIEW

Upon completion of the borings logs, copies shall be made and reviewed. Items to be reviewed include:

- Checking for consistency of all logs
- Checking for conformance to the guideline
- Checking to see that all information is entered in their respective columns and spaces

6.0 REFERENCES

Unified Soil Classification System (USCS)

ASTM D2488, 1985

Earth Manual, U.S. Department of the Interior, 1974

7.0 RECORDS

Originals of the boring logs shall be retained in the project files.

EXHIBIT 4-1

BORING LOG **NUS CORPORATION**

PROJECT: BORING NO.:
PROJECT NO.: DATE: DRILLER:
ELEVATION: FIELD GEOLOGIST:
WATER LEVEL DATA
(Date, Time & Conditions)

SAMPLE NO. & TYPE OR RQD	DEPTH (FT.) OR RUN NO.	BLOWS/6" OR RQD (%)	SAMPLE RECOVERY/ SAMPLE LENGTH	LITHOLOGY CHANGE (Depth/Ft.) OR SCREENED INTERVAL	MATERIAL DESCRIPTION			U S C S	REMARKS
					SOIL DENSITY/ CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION		

REMARKS ______________________________________
____
____

BORING ________

PAGE ____ OF ____

EXHIBIT 4-2

SOIL TERMS

UNIFIED SOIL CLASSIFICATION (USCS)

COARSE GRAINED SOILS

More than half of material is LARGER than No. 200 sieve size

		FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights)	GROUP SYMBOL	TYPICAL NAMES
GRAVELS 50% (+) > 1/4" Ø	CLEAN GRAVELS (Low % fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	Well graded gravels, gravel sand mixtures, little or no fines
		Predominantly one size or a range of sizes with some intermediate sizes missing	GP	Poorly graded gravels, gravel sand mixtures, little or no fines
	GRAVELS W/FINES (High % fines)	Non plastic fines (for identification procedures see ML)	GM	Silty gravels, poorly graded gravel sand silt mixtures
		Plastic fines (for identification procedures see CL)	GC	Clayey gravels, poorly graded gravel sand clay mixtures
SANDS 50% (+) < 1/4" Ø	CLEAN SANDS (Low % fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes	SW	Well graded sand, gravelly sands, little or no fines
		Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Poorly graded sands, gravelly sands, little or no fines
	SANDS W/FINES (High % fines)	Non plastic fines (for identification procedures see ML)	SM	Silty sands, poorly graded sand silt mixtures
		Plastic fines (for identification procedures see CL)	SC	Clayey sands, poorly graded sand clay mixtures

FINE GRAINED SOILS

More than half of material is SMALLER than No. 200 sieve size

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights)

Identification procedures on fraction smaller than No. 40 sieve size

	DRY STRENGTH (Crushing Characteristics)	DILATANCY (Reaction to Shaking)	TOUGHNESS (Consistency Near Plastic Limit)	GROUP SYMBOL	TYPICAL NAMES
SILTS & CLAYS Liquid limit < 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
	Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	Slight to medium	Slow	Slight	OL	Organic silts and organic silt clays of low plasticity
SILTS & CLAYS Liquid limit > 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays
	Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel and frequently by fibrous texture			Pt	Peat and other organic soils

Boundary classifications: Soils possessing characteristics of two groups are designated by combining group symbols. For example GW-GC, well graded gravel sand mixture with clay binder.
All sieve sizes on this chart are U.S. Standard.

DENSITY OF GRANULAR SOILS

DESIGNATION	STANDARD PENETRATION RESISTANCE - BLOWS/FOOT
Very loose	0-4
Loose	5-10
Medium dense	11-30
Dense	31-50
Very dense	Over 50

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNC COMPRESSIVE STR. TONS/SQ FT	STANDARD PENETRATION RESISTANCE - BLOWS/FOOT	FIELD IDENTIFICATION METHODS
Very soft	Less than 0.25	0 to 2	Easily penetrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb
Medium stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb
Stiff	1.0 to 2.0	8 to 15	Readily indented by thumb
Very stiff	2.0 to 4.0	15 to 30	Readily indented by thumbnail
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail

ROCK TERMS

ROCK HARDNESS (FROM CORE SAMPLES)

DESCRIPTIVE TERMS	SCREWDRIVER OR KNIFE EFFECTS	HAMMER EFFECTS
Soft	Easily gouged	Crushes when pressed with hammer
Medium soft	Can be gouged	Breaks (one blow) Crumbly edges
Medium hard	Can be scratched	Breaks (one blow) Sharp edges
Hard	Cannot be scratched	Breaks conchoidally (several blows) Sharp edges

ROCK BROKENNESS

DESCRIPTIVE TERMS	ABBREVIATION	SPACING
Very broken	(V. Br.)	0-2"
Broken	(Br.)	2"-1'
Blocky	(Bl.)	1'-3'
Massive	(M.)	3'-10'

LEGEND

SOIL SAMPLES - TYPES

S - 2" O.D. Split Barrel Sample
ST - 3" O.D. Undisturbed Sample
O - Other Samples, Specify in Remarks

ROCK SAMPLES - TYPES

X - NX (Conventional) Core (- 2 1/8" O.D.)
Q - NQ (Wireline) Core (- 1 7/8" O.D.)
Z - Other Core Sizes, Specify in Remarks

WATER LEVELS

12/18
- 12.6 Initial Level w/Date & Depth

12/18
- 12.6' Stabilized Level w/Date & Depth

EXHIBIT 4-3

CONSISTENCY FOR COHESIVE SOILS

Consistency	(Blows per Foot)	Unconfined Compressive Strength (tons/square foot by pocket penetration	Field Identification
Very soft	0 to 2	Less than 0.25	Easily penetrated several inches by fist
Soft	2 to 4	0.25 to 0.50	Easily penetrated several inches by thumb
Medium stiff	4 to 8	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort
Stiff	8 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort
Very stiff	15 to 30	2.0 to 4.0	Readily indented by thumbnail
Hard	Over 30	More than 4.0	Indented by thumbnail

EXHIBIT 4-4

BEDDING THICKNESS CLASSIFICATION

Thickness (Metric)	Thickness (Approximate English Equivalent)	Classification
> 1.0 meter	> 3.3'	Massive
30 cm - 1 meter	1.0' - 3.3'	Thick Bedded
10 cm - 30 cm	4" - 1.0'	Medium Bedded
3 cm - 10 cm	1" - 4"	Thin Bedded
1 cm - 3 cm	2/5" - 1"	Very Thin Bedded
3 mm - 1 cm	1/8" - 2/5"	Laminated
1 mm - 3 mm	1/32" - 1/8"	Thinly Laminated
< 1 mm	< 1/32"	Micro Laminated

(Weir, 1973 and Ingram, 1954)

EXHIBIT 4-5

GRAIN SIZE CLASSIFICATION FOR ROCKS

Particle Name	Grain Size Diameter
Cobbles	> 64 mm
Pebbles	4-64 mm
Granules	2-4 mm
Very Coarse Sand	1-2 mm
Coarse Sand	0.5-1 mm
Medium Sand	0.25-0.5 mm
Fine Sand	0.125-0.25 mm
Very Fine Sand	0.0625-0.125 mm
Silt	0.0039-0.0625 mm

After Wentworth, 1922

BORING LOG — **NUS CORPORATION**

PROJECT HEBELKA SITE — BORING NO. MW 3A
PROJECT NO. 5.9Y — DATE: 9-21-87 — DRILLER B. GOLLHUE
ELEVATION 5.0-07 — FIELD GEOLOGIST SJ CONTI
WATER LEVEL DATA (Date, Time & Conditions) WL 26.35 - TPVC 10-16-87

SAMPLE NO. & TYPE/RQD	DEPTH (FT.)/RUN NO.	BLOWS/6" OR RQD (%)	SAMPLE RECOVERY/SAMPLE LENGTH	LITHOLOGY CHANGE (Depth ft.) OR SCREEN INT.	SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS/ROCK	REMARKS
S-1	0.0	3 / 6	1.5/1.5		STIFF	BRN	CLAYEY SILT - TR SHALE FRAG - TR ORG.	ML	0-6" TOPSOIL MOIST 0PPM RESIDUAL SOIL
	1.5	6							
	5.0								
S-2	6.0	11 / 100/.5	0.8/1.0	5.5 / 6.0	M.SOFT TO M.HARD	GRAY BRN	DEC SHALE AND SILT	VBR	DAMP 0PPM REFUSAL @ 6' 5.5 TOP OF DEC ROCK AUGERED TO 15' W/SOLID STEM AUG CUTTING MOIST @ 8' WATER @ 11'± WL @ 12:10 PM WAS ≈ 9' FROM GS. SET 4" PVC CAS. @ 9.0'
9-21 / 9-22	15.0								
					M.HARD	BRN GRAY	SILTY SHALE - FEW QUARTZ PCS	VBR	SEVERAL 0 PPM Fe STAINED JOINTS ON CORE THRUOUT RUN JOINTS AND BREAKS ARE HORIZ TO LO 4. W/VUGS ON LOWER PORTION 23 TO 25 OF CORE
2.2/10.0	①	2.2/10	7.8/10.0						
	25.0								

REMARKS ACKER AD II RIG - SOLID STEM AUGERS USED TO ADVANCE BORINGS - 140 LB WT & 30" DROP - TO TAKE 2" Φ SP. SPOON SAMPLES - SET UP OVER HOLE @ 11:10 AM. WILL SAMPLE THIS HOLE - SET 4" CASING THEN DO SHALLOW WELL. STARTED TO CORE 9-22-87 USING THE WIRE-LINE CORING METHOD.

* See Legend on Back

BORING MW 3A

PAGE 1 OF 3

BORING LOG NUS CORPORATION

PROJECT HEBELKA SITE BORING NO MW 3A
PROJECT NO 619Y DATE 9-22-87 DRILLER B. GOLLIHUE
ELEVATION FIELD GEOLOGIST SJ CONTI
WATER LEVEL DATA
(Date, Time & Conditions)

Sample No & Type RQD	Depth (ft) RUN	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/ft)	Soil Density/Consistency or Rock Hardness	Color	Material Classification	USCS	Remarks
9-22	25.0				M.HARD	GRAY	SILTY SHALE	VBR	SHALE IS VBR W/ HORIZ TO LO ∠ JNTS
							(SILTSTONE)		≈26 TO 27 2-VERT
							- FEW QUARTZ		JOINTS. IRON STAINS ON JNTS
							SEAMS		ROCK BECOMES AND BREAKS MORE LIKE
									A SILTSTONE WITH DEPTH.
0/10.0	②	0%	8.7/10.0						
								BR	≈32 TO 33 FEW QUARTZ PIECES W/
								VBR	VUGS. SL. MICACEOUS
									VF QUARTZ GRAINS IN MATRIX - 30X MAG.
									≈34 TO 35 - 2 VERT JOINTS
	35.0								
					M.HARD	GRAY	SILTY SHALE (SILTSTONE)	VBR	35.0-35.5 QUARTZ PIECES
							- FEW QUARTZ	BR	
							SEAMS	VBR	BECOMES SL. CALCAR. @ 37± THIN CALCITE
									LAMINATIONS WATER STAINED JNTS
								BR	THRUOUT RUN MORE SO 35-37±
1.0/10.0	③	10%	9.3/10.0					VBR	39.5 → 42.0
									42.7 → 43.0 HI ∠ JNT
								BR	42.4 → 42.7 VERT JNT
	45.0							VBR	
									45.3 → 45.5 VERT JNT. & VBR
									47.5 VERT JOINT
								BR	48. HI ∠ JOINT
									SLIGHTLY CALCAREOUS MORE CALCITE
									PRESENT

REMARKS ______

BORING MW 3A

PAGE 2 OF 3

* See Legend on Back

CP-00402-3.05-10/1/90

BOREHOLE AND SAMPLE LOGGING

BORING LOG — NUS CORPORATION

PROJECT HEBELKA SITE — BORING NO MW 3A
PROJECT NO 3-3Y — DATE 9-22-87 — DRILLER B. GOLLINUE
ELEVATION — FIELD GEOLOGIST SJ CONTI
WATER LEVEL DATA
(Date, Time & Conditions)

Sample No. & Type	Depth (Ft.)	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth Ft.)	Soil Density Consistency or Rock Hardness	Color	Material Classification	USCS	Remarks
1.9/10.0	4	19%	10.0/10.0		M. HARD	GRAY	SILTY SHALE (SILTSTONE)	VBR	50.5 → 51.0 VBR
							SL. CALCAREOUS	BR	51.5 → 54.0 BR w/ SEV LO & JOINTS
	55.0								
								VBR	POOR RECOVERY w/ SOFT ZONES.
0/10	5	0%	1.8/10.0						
	65.0								
				66					
									68.0 - DRILLER NOTED SOFT AREA - LOSS OF 1/3 OF WATER - CHANGE IN COLOR OF DRILL WATER TO YELLOW BROWN
0/0	6	0%	1.3/10.0						POOR RECOVERY
									FEW CALCAREOUS ZONES.
	75.0			76					

REMARKS AT 75' @ 1:45 PM - PULLING TOOLS - TO REAM HOLE.
AT 1:50 PM CORED HOLE TO 75' REAMED TWICE
DUE TO RUNNING SAND (FRACTURE) AT ≈ 68. REAMED
2ND TIME TO 81'. SET WELL 66-76'.

BORING MW 3A

PAGE 3 OF 3

* See Legend on Back

EXHIBIT 4-6

BORING LOG — NUS CORPORATION

PROJECT WESTLINE SITE — BORING NO. MW 313
PROJECT NO. -73Y — DATE 7-7-87 — DRILLER B. FRIXSON
ELEVATION 1462.37 — FIELD GEOLOGIST SJ CONTI — PENN-DRILL
WATER LEVEL DATA 5.54' @ 8:50 AM 7-23-87 T-PVC — ACKER AD-II
(Date, Time & Conditions)

SAMPLE NO. & TYPE OR RQD	DEPTH (FT.) OR RUN NO.	BLOWS / 6" OR RQD (%)	SAMPLE RECOVERY / SAMPLE LENGTH	LITHOLOGY CHANGE (Depth/Ft.) OR SCREEN INT.	SOIL DENSITY / CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	U S C S	REMARKS (HNU) HEAD SP
	0.0	5 / 3	1.4/1.5		Loose	BLK BRN	CLAYEY SILT AND CINDERS	ML	MOIST (0PPM)
S-1		2					TR. COAL FRAG		3/4 O FRAG - NEAR OLD RR. LINE.
							TR-CC FRAG		
							(FILL)		
	5.0					RED			
S-2		1 / 1	1.3/1.5	6.0	V LOOSE	BRN TO GRAY	SANDY SILT - TR GRAVEL	SM	MOIST → WET (0PPM)
	6.5	3					SILTY SAND - TR GRAVEL		GRAY SAND & ± MICACEOUS
									ODOR & MOTTLING
									DRILLER NOTE H2O 8-10'
	10.0								
S-3		11 / 23	1.2/1.5		DENSE	BRN	SILTY SAND AND S.S.	GM	WET (0PPM)
	11.5	27					FRAGS. (GRAV)		1"Ø SIZE MAX SIZE
									SUBANGULAR → SUBROUNDED GRAVEL
	15.0								
S-4		7 / 47	1.0/1.5		V. DENSE	BRN	SILTY FINE TO C. SAND	SM	WET (0PPM)
	16.5	43					AND GRAVEL		1"Ø SIZE MAX SIZE
									SUBANGULAR TO SUBROUNDED GRAVEL
	20.0								
S-5	20.9	17 / 50/.4	.4/.9		V. DENSE	ORANG BRN	SILTY SAND - SOME	GM	WET (0PPM)
							GRAVEL AND		MOIST
							S.S FRAGS		BECOMES MORE LIKE SANDY SILT AT BOTTM OF SAMPLE

REMARKS START @ 1:15 PM - 7-7-87 USING 4 1/4" ID HOLLOW STEMS
S-4 @ 3:30 PM TO ADVANCE THE BORINGS USING
S-5 @ 4:30 PM ACKER DRILL - MOUNTED ON
FORD 3000 TRUCK

SAMPLES TAKEN
USING 140 lb WT AND 30 INCH DROP.

BORING MW 313

PAGE 1 OF 4

BORING LOG — NUS CORPORATION

PROJECT: WESTLINE SITE | BORING NO: MW013
PROJECT NO: 473Y | DATE: 7-7-87 | DRILLER: S ERICSON
ELEVATION | FIELD GEOLOGIST: SJ CONTI
WATER LEVEL DATA (Date, Time & Conditions)

SAMPLE NO. & TYPE OR RQD	DEPTH (FT) OR RUN NO	BLOWS / 6" OR RQD (%)	SAMPLE RECOVERY / SAMPLE LENGTH	LITHOLOGY CHANGE (DEPTH FT) OR SCREEN INT	SOIL DENSITY / CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS	REMARKS
S-6	25.0	6 / 17	1.1/1.5		DENSE	OLIVE BLUE	SILTY SAND - SOME	SM	[illegible]
	26.5	30				GRAY	GRAVEL - TR CLAY		[illegible]
							TR. SS FRAG		COLOR. NOT ENOUGH CLAY TO BE CONFINING
									NOTE: MAY SET ZONE 2
	30.0								CASING @ 38'
S-7		17 / 27	1.4/1.5		V DENSE	[illegible]	SILTY SAND - SAND [illegible]	SM/GM	[illegible]
	31.5	36				[illegible]	[illegible]		[illegible]
							TR CLAY		[illegible]
									[illegible] BUT MAY BE SEMI-CONFINING.
	35.0								
S-8	35.3	30 / 50/.4	0.7/0.9		V.DENSE	BLUE GRAY	SILTY F TO C SAND -	SM/GM	[illegible]
							SOME GRAVEL		[illegible]
							TR SS FRAG		[illegible] FRAG - MORE [illegible]
									ABOVE
	40.0					BLUE			POSSIBLE 3 TO 4 5 SCREEN LOC. SQUEEZED
S-9		31 / 34	1.2/1.5		V.DENSE	BRN GRAY	SILTY SAND (FINE TO M.)	SM/GM	MOIST → WET OPPM
	41.5	24					SOME GRAVEL TR		LITTLE MORE CLAY THAN
							CLAY		S-8 SUBROUNDED GRAVEL
									VERY SLOW DRILLING 40-41.5 (RIG STALLS)
	45.0					BLUE			[illegible] SAMPLE
S-10		13 / 34	1.2/1.5		V.DENSE	BRN GRAY	SILTY SAND (FINE TO M.)	SM/GM	MOIST [illegible]
	46.5	50					SOME GRAVEL - TR		[illegible] SQUEEZED
							CLAY		[illegible]
									[illegible] TO 50'

REMARKS: S-6 @ 4:40 PM
S-8 @ 8:36 AM 7-8-87
S-10 @ 10.40 [illegible] S-11 [illegible]

BORING MW013
PAGE 2 OF 4

BORING LOG — **NUS CORPORATION**

PROJECT: WESTLINE SITE — BORING NO. MW 013
PROJECT NO. 473Y — DATE 7-9-87 — DRILLER B. ERICSON
ELEVATION — FIELD GEOLOGIST S. LOUIS
WATER LEVEL DATA
(Date, Time & Conditions)

	SAMPLE NO. & TYPE OR RQD	DEPTH (FT.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY / SAMPLE LENGTH	LITHOLOGY CHANGE (Depth Ft.) OR SCREEN INT.	SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	U.S.C.S.	REMARKS
	S-11	50.0	15 / 41	1.3/1.3		V. DENSE	MOTTLED BLUE GRY	SILTY SAND - SOME GR	GM	MOIST - (OPPM)
		51.3	50/.3				SCAT	TR CLAY	SM	MOTTLED W/ PCS OF BLACK COAL/LIGNITE
										MORE CLAY THAN ABOVE PORTIONS OF SAMPLE -
										COHESIVE SAMPLE.
		55.0			55.0					
	S-12		11 / 15	1.4/1.5		V. STIFF	GRAY ORANG	SANDY CLAY / CLAYEY SAND	SC	MOIST → WET (OPPM)
		56.5	26			TO STIFF	BRN	SOME GRAVEL		NOTE COLOR CHANGE ALSO - MORE CLAY
										THAN ANY SAMPLE SUB-ROUNDED GRAINS
										FIRST COHESIVE TYPE SAMPLE.
		60.0	40							
	S-13	60.9	50/.4	0.9/0.9		V. DENSE	ORANG BRN	SANDY CLAY/ CLAYEY SAND - SOME	SC/	MOIST → WET (OPPM)
								GRAVEL	SM	NOT AS MUCH CLAY AS S-12 BUT VERY
										COMPACT.
										SUBROUNDED GRAINS
										SET CAS. @ 62'.
		65.0								
7/13	S-14	65.8	37 / 50/.3	0.8/0.8		V DENSE	BRN ORANG	SILTY SAND - SOME GR	GM/	MOIST (OPPM)
								AND ROCK FRAG -	GW	MORE CLAY TOWARDS
					68.0			TR. CLAY		TOP OF SAMPLE MAX 3/4" D SIZE
							YELLOW BRN			COLOR CHANGE AT 68' MORE SAND PER
		70.0								DRILLER - BOTTOM OF SEMI CONF LAYER ?
7/14	S-15		39 / 39	1.5/1.5		V. DENSE	YELLOW BRN	CLAYEY SAND (F TO C.) SOME	SC/	MOIST → WET (OPPM)
		71.5	41					GRAVEL - TR	GC	1" MAX GRAVEL
								ROCK FRAG.		MORE GRAVEL @ 72'
										PER DRILLER

REMARKS: USING HOLLOW STEM TO ADVANCE BORING - WASHING OUT THRU AUGERS, WHEN NEEDED TO OBTAIN SAMPLE
S-12 @ 1:46 PM
S-13 → 3.32 PM - LOGGED IN BY 3:47 PM
SET 6" ϕ STEEL CASING TO 62' - WILL DRILL BELOW CASING AFTER GROUT SETS UP. S-14 @ 3:50 PM 7-13-87
S-15 @ 7:57 AM 7-14-87

BORING MW 013

PAGE 3 OF 4

BORING LOG NUS CORPORATION

PROJECT WESTLINE SITE
PROJECT NO -37Y
ELEVATION
WATER LEVEL DATA
(Date, Time & Conditions)

DATE 7-13-87 / 7-14-87
FIELD GEOLOGIST SJ CONTI

BORING NO MW013
DRILLER B. ERICSON

SAMPLE NO. & TYPE OR RQD	DEPTH (Ft.) OR RUN NO.	BLOWS 6" OR RQD (%)	SAMPLE RECOVERY SAMPLE LENGTH	LITHOLOGY CHANGE (Depth/Ft.) OR SCR. INT.	SOIL DENSITY CONSISTENCY OR ROCK HARDNESS	COLOR	MATERIAL CLASSIFICATION	USCS	REMARKS HNU
S-16	75.0	28 / 50	0.9/1.0		V. DENSE	GRAY ORANG	FINE TO C. CLAYEY SAND - SOME	SC	WET (0PPM)
	76.0	.5				BRN	GRAVEL - TR		NOT AS MUCH CLAY AS S-15 - BOTTOM OF
							ROCK FRAG (S.S.)		SAMPLE BECOMES MORE SANDY
									MAX 1" R.F.
	80.0								NO SAMPLE @ 80' -
									DECIDED TO GO TO 85
	85.0	50/	0.4/0.4		V. DENSE	GRAY ORANG.	SILTY F. TO C SAND - SOME	SW	WET (0PPM)
S-17	85.4	.4		85		BRN	GRAVEL - TR		SUBROUNDED GRAINS
							S.S. FRAG - TR		V. SL TR CLAY - WILL
							CLAY		SET SCREEN ≈ 75 TO 85' IN THIS
									BORING.
							BOTM OF HOLE		
							@ 85.0'		

REMARKS S-17 @ 2:20 PM 7-14-87 - [illegible] 6" CASING SPUN 4" ID - 5⅞" OD [illegible] TO BOTM. USING WATER AS DRILLING FLUID

BORING MW013

PAGE 4 OF 4

1.0 PURPOSE

The purpose of this procedure is to provide reference information regarding the appropriate procedures to be followed when conducting decontamination activities of drilling equipment and monitoring well materials used during field investigations.

2.0 SCOPE

This procedure addresses only drilling equipment and monitoring well materials decontamination, and shall not be considered for use with chemical sampling and field analytical equipment decontamination.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Field Operations Leader - Responsible for ensuring that project specific plans and the implementation of field investigations are in compliance with these procedures.

5.0 PROCEDURE

To insure that analytical chemical results are reflective of the actual concentrations present at sampling locations, various drilling equipment involved in field investigations must be properly decontaminated. This will minimize the potential for cross-contamination between sampling locations, and the transfer of contamination off site.

Prior to the initiation of a drilling program. all drilling equipment involved in field sampling activities shall be decontaminated by steam cleaning at a predetermined area. The steam cleaning procedure shall be performed using a high-pressure spray of heated potable water producing a pressurized stream of steam. This steam shall be sprayed directly onto all surfaces of the various equipment involved in field investigations. The decontamination procedure shall be performed until all equipment is free of all visible potential contamination (dirt, grease, oil, noticeable odors, etc.) In addition, this decontamination procedure shall be performed at the completion of each sampling and/or drilling location, including soil borings, installation of monitoring wells, test pits, etc. Such equipment shall include drilling rigs, backhoes, downhole tools, augers, well casings, and screens. The steam cleaning area shall be designed to contain decontamination wastes and waste waters, and can be a lined excavated pit or a bermed concrete or asphalt pad. For the latter, a floor drain must be provided which is connected to a holding facility. A shallow above-surface tank may be used or a pumping system with discharge to a waste tank may be installed.

In certain cases, due to budget constraints, such an elaborate decontamination pad is not possible. In such cases, a plastic lined gravel bed pad with a collection system may serve as an adequate decontamination area. The location of the steam cleaning area shall be on site in order to minimize potential impacts at certain sites. Due to the types of contaminants or proximity to residences, concerns may exist about air emissions from steam cleaning operations. These concerns can be alleviated by utilizing an enclosed steam cleaning area. For example, augers and drill rods can be steam cleaned in drums that have been modified. Tarpaulins can also be placed around the steam cleaning area to control emissions.

Guidance to be used when decontaminating equipment shall include:

- As a general rule, any part of the drilling rig which extends over the borehole, shall be steam cleaned.
- All drilling rods, augers, and any other equipment which will be introduced to the hole shall be steam cleaned.
- The drilling rig, all rods and augers, and any other potentially contaminated equipment shall be decontaminated between each well location to prevent cross contamination of potential hazardous substances.

Rinsate samples of well casing and screens may be necessary if specifically required for a given site. If required, at least 1 percent, and no more than 5 percent of steam cleaned lengths of casing and screens combined shall be sampled.

Prior to leaving at the end of each work day and/or at the completion of the drilling program, drilling rigs and transport vehicles used onsite for personnel or equipment transfer shall be steam cleaned. A drilling rig left at the drilling location does not need to be steam cleaned until it is finished drilling at that location.

6.0 REFERENCES

Ebasco Services Incorporated; REM III Field Technical Guideline No. FT-6.03; October 27, 1987.

7.0 RECORDS

None.

required to perform the field tests. All applicable data regarding testing procedures, equipment used, well construction, and geologic/hydrogeologic conditions shall be recorded by the field geologist. The field geologist shall be familiar enough with testing procedures/requirements to be able to recommend changes in methodology, should unanticipated field conditions be encountered.

5.0 PROCEDURES

5.1 <u>In-Situ Hydraulic Conductivity Testing in Wells</u>

Slug tests are commonly performed in completed wells. Prior to testing, the well shall be thoroughly developed and allowed to stabilize, in order to obtain accurate results. Once the water level within the well has stabilized, it shall be quickly raised or lowered and the rate of recovery measured.

One of the basic assumptions of slug testing is that the initial change in water level is instantaneous; therefore, an effort shall be made to minimize the time involved in raising or lowering the water level initially. Various methods can be used to induce instantaneous (or nearly instantaneous) changes in water level within the well. A rise in water levels can be induced by pouring water into the well. A slug of known volume, quickly lowered below the water level within the well, will displace an equivalent volume of water and raise the water level within the well. The same type of slug can be placed below the static water level in the well, left in place until the water level restabilizes at the static water level, then suddenly removed to create a drop in water level within the well. An advantage of using a solid cylinder of known volume to change the water level (slug test) is that no water is removed or added to the monitoring well. This eliminates the need to dispose of contaminated water. A bailer or pump can be used to withdraw water from the well. (If a pump is used, pumping shall not continue for more than several seconds so that a cone of depression is not created which would adversely impact testing results. The pump hose shall also be removed from the well during the recovery period, as data analysis techniques involve volume of recovery versus time, and leaving the hose within the well would distort the calculated testing results by altering the apparent volume of recovery.) Falling head slug tests can only be performed in wells with fully submerged screens, while rising head slug tests can be performed in wells with either partially or fully submerged screens/open intervals.

Other methods that can be used to change water levels within a well include creating a vacuum or a high pressure environment within the well. The vacuum method will raise water levels within the well, while the pressure method will depress the water level in the well. These methods are particularly useful in highly permeable formations where other methods are ineffective in creating measurable changes in water levels. Both methods are limited to wells which have completely submerged screens.

Rate of recovery measurements shall be obtained from time zero (maximum change in water level) until water level recovery exceeds 90 percent of the initial change in water level. In low permeability formations, the test may be cut off short of 90 percent recovery due to time constraints. Time intervals between water level readings will vary according to the rate of recovery of the well. For a moderately fast recovering well, water level readings at 0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.75, 1.0, 1.25, 1.5, 2.0, 2.5, 3.0, 4.0, . . minutes may be required. With practice, readings at down to 0.05-minute (3 seconds) time intervals can be obtained with reasonable accuracy, using a pressure transducer and hand held readout. For wells which recover very fast, a pressure transducer and data logger may be required to obtain representative data. Time intervals between measurements can be extended for slow recovering wells. A typical schedule for measurements for a slow recovering well would be 0, 0.25, 0.5, 0.75, 1.0, 1.5, 2.0, 3.0, 4.0, 6.0, 8.0, 10.0, 15.0, 20.0, 30.0, . . . minutes from the beginning the test. Measurements shall be taken from the top of the well casing.

Water level measurements can be obtained using an electric water level indicator, popper, or pressure transducer. Chalked steel tape, although very accurate, is a slower method of obtaining water levels and is generally not recommended for use due to the frequency at which water levels need to be taken during the performance of a slug test.

The following data shall be obtained when performing slug tests in wells or borings:

- Well/boring ID no.
- Total depth of well/boring
- Screened/open interval depth and length
- Gravel pack interval depth and length
- Well and boring radii
- Well stickup above ground surface
- Gravel pack radius
- Static water level
- Aquifer thickness
- Depth to confining layer
- Time/recovery data

A variation of the slug test is a test in which water is added to the well at a measured rate sufficient to maintain the water level in the well at a constant height above the static water level, and is called a constant-head test. Once a stable elevated water level has been achieved, discharge (pumping) rate measurements shall be recorded in place of time/recovery data for approximately 10 to 20 minutes, then the hydraulic conductivity calculated from this. This type of test is generally not recommended for monitoring wells as large volumes of water may be introduced into the screened formation, potentially impacting later sampling events.

5.2 In-Situ Hydraulic Conductivity Testing in Borings

Slug tests can be performed in borings while the boring is being advanced. This permits testing of formations at different depths throughout the drilling process. Boreholes to be tested shall be drilled using casing, so that discrete depths may be investigated. Various tests and testing methods are described below. The most appropriate test and testing method to be used in a situation varies with drilling, geologic, and general site conditions and shall be selected after a careful evaluation of the above factors.

Rising head or falling head slug tests can be performed in saturated and unsaturated formations during drilling. There are two ways that the tests can be performed. One way entails setting the casing flush with the bottom of the boring when the desired testing depth has been reached. The hole is then cleaned out to remove loose materials, the drill bit and rods are carefully withdrawn from the boring, and a few feet of sand (of higher permeability than the surrounding formation) is added to the bottom of the boring. After the water level in the boring has stabilized (for saturated formations), the static water level shall be measured and recorded. The water level shall then be raised (falling head test) or lowered (rising head test) and the change in water level measured at time intervals as determined by the field hydrogeologist. Only falling head tests can be performed for depth intervals within the unsaturated (vadose) zone. As described for wells, time intervals for water-level measurements will vary according to the formation's hydraulic conductivity. The faster the rate of recovery expected, the shorter the time intervals between measurements shall be. A predetermined pattern of time intervals shall be used during each test. The rate of change of water level will be used to calculate hydraulic conductivity. The test shall be conducted until the water level again stabilizes, or for a minimum of 20 minutes. In low permeability formations, it is not always practical to run the test until the water level stabilizes, as it may take a long time to do so. The top of the casing shall be used as the reference point for all water level measurements.

The second method consists of placing a temporary well with a short screen into the cleaned out boring, pulling the drilling casing back to expose the screen, allowing the formation to collapse around the screen (or placing a sand/gravel pack around the screen), and performing the appropriate hydraulic conductivity test in the well, as described for the first method. Again, the test shall be conducted until the water level stabilizes or for a minimum of 20 minutes. this method allows for testing a larger section of the formation and results in more reliable hydraulic conductivity estimates.

Constant head tests may also be performed in borings. As described for monitoring wells, once a stable elevated level has been achieved, the discharge rate into the boring is measured for a period of time, usually 10 to 20 minutes, and the hydraulic conductivity calculated from this. This method is the most accurate method depicted in this section and shall be given preference over others if the materials are available to perform the test and the addition of water to the boring does not adversely impact project objectives. Once the test is over, additional information can be gathered by measuring the rate of the drop in water level in the boring (for saturated formations). A limitation of the test is that foreign water is introduced into the formation which must be removed from the well area by natural or artificial means before a representative groundwater sample can be obtained.

Detailed descriptions regarding the performance of borehole hydraulic conductivity tests and subsequent data analysis techniques are provided in Ground Water Manual (1981).

5.3 Data Analysis

There are a number of data analysis methods available for use to reduce and evaluate slug testing data. The determination of which method is most appropriate shall be made based on the testing conditions (including physical setup of the well/boring tested, hydrogeologic conditions, and testing methodology) and the limitations of each test analysis method. Well construction details, aquifer type (confined or unconfined), and screened/open interval (fully or partially penetrating the aquifer) shall be taken into account in selecting an analysis method. Cooper, et al. (1967), and Papadapulos, et al. (1973), have developed test interpretation procedures for fully penetrating wells in confined aquifers. Hvorslev (1951) developed a relatively simple analytical procedure for point piezometers in an infinite isotropic medium. In Cedergren (1967), Hvorslev presents a number of analytical procedures which cover a wide variety of hydrogeologic conditions, testing procedures, and well/boring/ piezometer configurations. Bouwer and Rice (1976) developed an analytical technique applicable to both unconfined and confined conditions, factors in partial/full penetration, and discusses well screen gravel pack considerations. The Ground Water Manual (1981) presents a number of testing and test analysis procedures for wells and borings open above or below the water table, and for both falling-head and constant-head tests. The methods described above do not represent a complete listing of test analysis methods available, but are some of the more commonly used and accepted methods. Other methods can be used, at the discretion of the project hydrogeologist.

One consideration to be noted during data analysis is the determination of the screened/open interval of a tested well. If a well is screened in a relatively low permeability formation, and a gravel pack which is significantly more permeable is installed around the screen, the length of the gravel pack (if longer than the screened interval) shall be used as the screened/open length, rather than the screen length itself. In situations where the formation permeability is judged to be comparable to the gravel pack permeability (within about an order of magnitude) this adjustment is not required.

All data analysis applications and calculations shall be reviewed by senior level personnel thoroughly familiar with testing and test analysis procedures. Upon approval of the calculations and results, the calculation sheets shall be initialed and dated by the reviewer. Distribution copies shall be supplied to appropriate project personnel and the original copy stored in the project file.

6.0 REFERENCES

Cedergren, H. R., 1967. Seepage, Drainage, and Flow Nets. John Wiley and Sons Inc., New York, pp. 78-76.

Cooper, H. H., Jr., J. D. Bredehoeft, and I. S. Papadopulos, 1967. Response of a Finite-Diameter Well to an Instantaneous Change of Water. Water Resources Research, v. 3, No. 1, pp. 263-269.

Hvorslev, M. J., 1951. Time Lag and Soil Permeability in Ground Water Observations. U.S. Army Corps of Engineers, Waterways Experiment Station, Washington, D.C., Bull. No. 36.

Papadopulos, I. S., J. D. Bredehoeft, and H. H. Cooper, 1973. On the Analysis of Slug Test Data. Water Resources Research, v. 9, No. 4, pp. 1087-1089.

Bouwer, H. and R. C. Rice, 1976. "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells." Water Resources Research, 12:423-28.

United States Department of the Interior, 1981. Ground Water Manual. U.S. Government Printing Office, Denver, CO.

7.0 RECORDS

Field data shall be recorded on the data sheet included as Attachment A. Any notes regarding testing procedures, problems encountered, and general observations not included on the data sheet shall be noted in the field logbook. The boring log and well construction diagrams for each well/boring tested shall be used as references during testing and data analysis activities. Original data sheets shall be placed in the project file, along with the field logbook.

ATTACHMENT A

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET — **NUS CORPORATION**

PROJECT NAME: ______ WELL/BORING NO.: ______
PROJECT NO.: ______ GEOLOGIST: ______
WELL DIAMETER: ______ SCREEN LENGTH/DEPTH: ______ TEST NO.: ______
STATIC WATER LEVEL (Depth/Elevation): ______ / ______ DATE: ______
TEST TYPE (Rising/Falling/Constant Head): ______ CHECKED: ______
METHOD OF INDUCING WATER LEVEL CHANGE: ______ PAGE ___ OF ___

TIME	ELAPSED TIME (min. or sec.)	MEASURED DEPTH TO WATER (ft.)	CORRECTION	DEPTH TO WATER (ft.)	DRAWDOWN OR HEAD (ft.)	REMARKS

Designation: D 1586 - 84

Standard Method for

PENETRATION TEST AND SPLIT-BARREL SAMPLING OF SOILS[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This method has been approved for use by agencies of the Department of Defense and for listing in the DOD Index of Specifications and Standards

1. Scope

1.1 This method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative soil sample and a measure of the resistance of the soil to penetration of the sampler.

1.2 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* For a specific precautionary statement, see 5.4.1.

1.3 The values stated in inch-pound units are to be regarded as the standard.

2. Applicable Documents

2.1 *ASTM Standards:*

D 2487 Test Method for Classification of Soils for Engineering Purposes[2]

D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)[2]

D 4220 Practices for Preserving and Transporting Soil Samples[2]

3. Descriptions of Terms Specific to This Standard

3.1 *anvil*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.2 *cathead*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.3 *drill rods*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.4 *drive-weight assembly*—a device consisting of the hammer, hammer fall guide, the anvil, and any hammer drop system.

3.5 *hammer*—that portion of the drive-weight assembly consisting of the 140 ± 2 lb (63.5 ± 1 kg) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.6 *hammer drop system*—that portion of the drive-weight assembly by which the operator accomplishes the lifting and dropping of the hammer to produce the blow.

3.7 *hammer fall guide*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.8 *N-value*—the blowcount representation of the penetration resistance of the soil. The N-value, reported in blows per foot, equals the sum of the number of blows required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.9 ΔN—the number of blows obtained from each of the 6-in. (150-mm) intervals of sampler penetration (see 7.3).

3.10 *number of rope turns*—the total contact angle between the rope and the cathead at the

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[1] This method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Investigations.

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[2] *Annual Book of ASTM Standards*, Vol 04.08.

beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.11 *sampling rods*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

3.12 *SPT*—abbreviation for Standard Penetration Test, a term by which engineers commonly refer to this method.

4. Significance and Use

4.1 This method provides a soil sample for identification purposes and for laboratory tests appropriate for soil obtained from a sampler that may produce large shear strain disturbance in the sample.

4.2 This method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate SPT blowcount, or *N*-value, and the engineering behavior of earthworks and foundations are available.

5. Apparatus

5.1 *Drilling Equipment*—Any drilling equipment that provides at the time of sampling a suitably clean open hole before insertion of the sampler and ensures that the penetration test is performed on undisturbed soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions.

5.1.1 *Drag, Chopping, and Fishtail Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjuction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 *Roller-Cone Bits*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 *Hollow-Stem Continuous Flight Augers*, with or without a center bit assembly, may be used to drill the boring. The inside diameter of the hollow-stem augers shall be less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm).

5.1.4 *Solid, Continuous Flight, Bucket and Hand Augers*, less than 6.5 in. (162 mm) and greater than 2.2 in. (56 mm) in diameter may be used if the soil on the side of the boring does not cave onto the sampler or sampling rods during sampling.

5.2 *Sampling Rods*—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod which has an outside diameter of 1⅝ in. (41.2 mm) and an inside diameter of 1⅛ in. (28.5 mm).

NOTE 1—Recent research and comparative testing indicates the type rod used, with stiffness ranging from "A" size rod to "N" size rod, will usually have a negligible effect on the *N*-values to depths of at least 100 ft (30 m).

5.3 *Split-Barrel Sampler*—The sampler shall be constructed with the dimensions indicated in Fig. 2. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The use of liners to produce a constant inside diameter of 1⅜ in. (35 mm) is permitted, but shall be noted on the penetration record if used. The use of a sample retainer basket is permitted, and should also be noted on the penetration record if used.

NOTE 2—Both theory and available test data suggest that *N*-values may increase between 10 to 30 % when liners are used.

5.4 *Drive-Weight Assembly*:

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lb (63.5 ± 1 kg) and shall be a solid rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting a free fall shall be used. Hammers used with the cathead and rope method shall have an unimpeded overlift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged.

NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic, or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The boring shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 mm) or less in homogeneous strata with test and sampling locations at every change of strata.

6.2 Any drilling procedure that provides a suitably clean and stable hole before insertion of the sampler and assures that the penetration test is performed on essentially undisturbed soil shall be acceptable. Each of the following procedures have proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

6.2.1 Open-hole rotary drilling method.

6.2.2 Continuous flight hollow-stem auger method.

6.2.3 Wash boring method.

6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable borings. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be permitted. The continuous flight solid auger method shall not be used for advancing the boring below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a boring with bottom discharge bits is not permissible. It is not permissible to advance the boring for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the boring or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the boring has been advanced to the desired sampling elevation and excessive cuttings have been removed, prepare for the test with the following sequence of operations.

7.1.1 Attach the split-barrel sampler to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the boring and apply a seating blow. If excessive cuttings are encountered at the bottom of the boring, remove the sampler and sampling rods from the boring and remove the cuttings.

7.1.4 Mark the drill rods in three successive 6-in. (0.15-m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 6-in. (0.15-m) increment.

7.2 Drive the sampler with blows from the 140-lb (63.5-kg) hammer and count the number of blows applied in each 6-in. (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 6-in. (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 18 in. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.3 Record the number of blows required to effect each 6 in. (0.15 m) of penetration or fraction thereof. The first 6 in. is considered to be a seating drive. The sum of the number of blows required for the second and third 6 in. of penetration is termed the "standard penetration resistance", or the "N-value". If the sampler is driven less than 18 in. (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 6-in. (0.15-m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 1 in. (25 mm), in addition to the number of blows. If the sampler advances below the bottom of the boring under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lb

(63.5-kg) hammer shall be accomplished using either of the following two methods:

7.4.1 By using a trip, automatic, or semi-automatic hammer drop system which lifts the 140-lb (63.5-kg) hammer and allows it to drop 30 ± 1.0 in. (0.76 m ± 25 mm) unimpeded.

7.4.2 By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM, or the approximate speed of rotation shall be reported on the boring log.

7.4.2.3 No more than 2¼ rope turns on the cathead may be used during the performance of the penetration test, as shown in Fig. 1.

NOTE 4—The operator should generally use either 1¾ or 2¼ rope turns, depending upon whether or not the rope comes off the top (1¾ turns) or the bottom (2¼ turns) of the cathead. It is generally known and accepted that 2¾ or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be maintained in a relatively dry, clean, and unfrayed condition.

7.4.2.4 For each hammer blow, a 30-in. (0.76-m) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

7.5 Bring the sampler to the surface and open. Record the percent recovery or the length of sample recovered. Describe the soil samples recovered as to composition, color, stratification, and condition, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 6-in. (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel.

8. Report

8.1 Drilling information shall be recorded in the field and shall include the following:

8.1.1 Name and location of job.

8.1.2 Names of crew.

8.1.3 Type and make of drilling machine.

8.1.4 Weather conditions.

8.1.5 Date and time of start and finish of boring.

8.1.6 Boring number and location (station and coordinates, if available and applicable).

8.1.7 Surface elevation, if available.

8.1.8 Method of advancing and cleaning the boring.

8.1.9 Method of keeping boring open.

8.1.10 Depth of water surface and drilling depth at the time of a noted loss of drilling fluid, and time and date when reading or notation was made.

8.1.11 Location of strata changes.

8.1.12 Size of casing, depth of cased portion of boring.

8.1.13 Equipment and method of driving sampler.

8.1.14 Type sampler and length and inside diameter of barrel (note use of liners).

8.1.15 Size, type, and section length of the sampling rods, and

8.1.16 Remarks.

8.2 Data obtained for each sample shall be recorded in the field and shall include the following:

8.2.1 Sample depth and, if utilized, the sample number.

8.2.2 Description of soil.

8.2.3 Strata changes within sample.

8.2.4 Sampler penetration and recovery lengths, and

8.2.5 Number of blows per 6-in. (0.15-m) or partial increment.

9. Precision and Bias

9.1 Variations in N-values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent borings in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, N-values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.2 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in N-values obtained between operator-drill rig systems.

9.3 The variability in N-values produced by different drill rigs and operators may be reduced by measuring that part of the hammer energy delivered into the drill rods from the sampler and adjusting N on the basis of comparative energies. A method for energy measurement and N-value adjustment is currently under development.

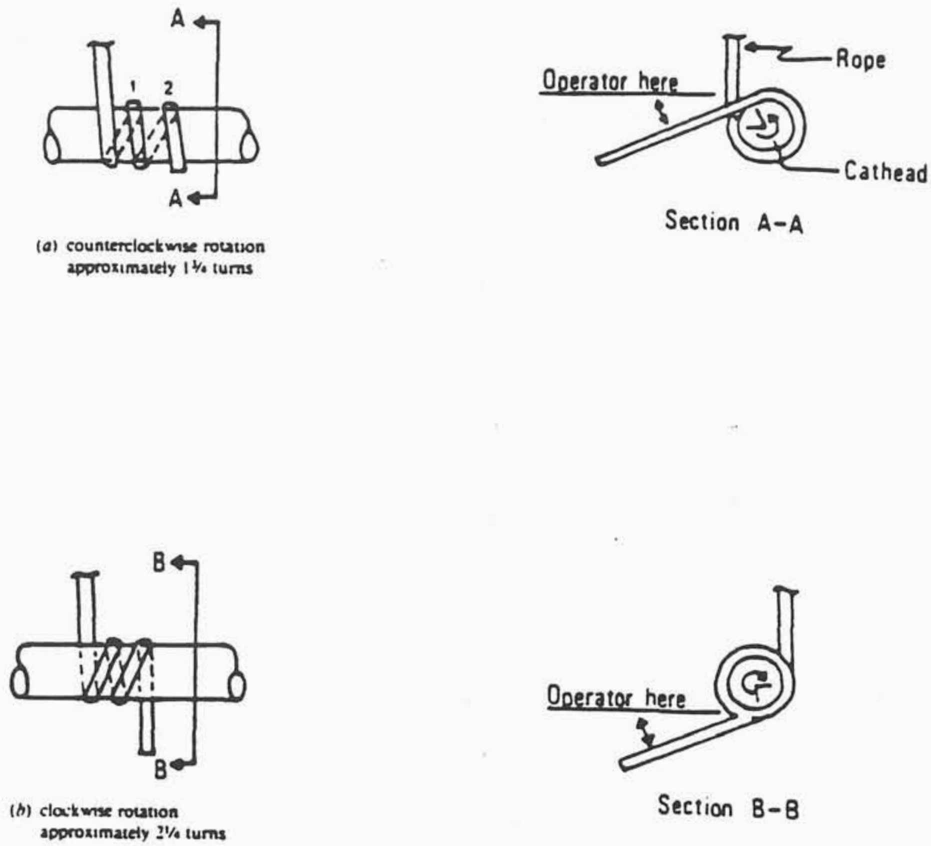
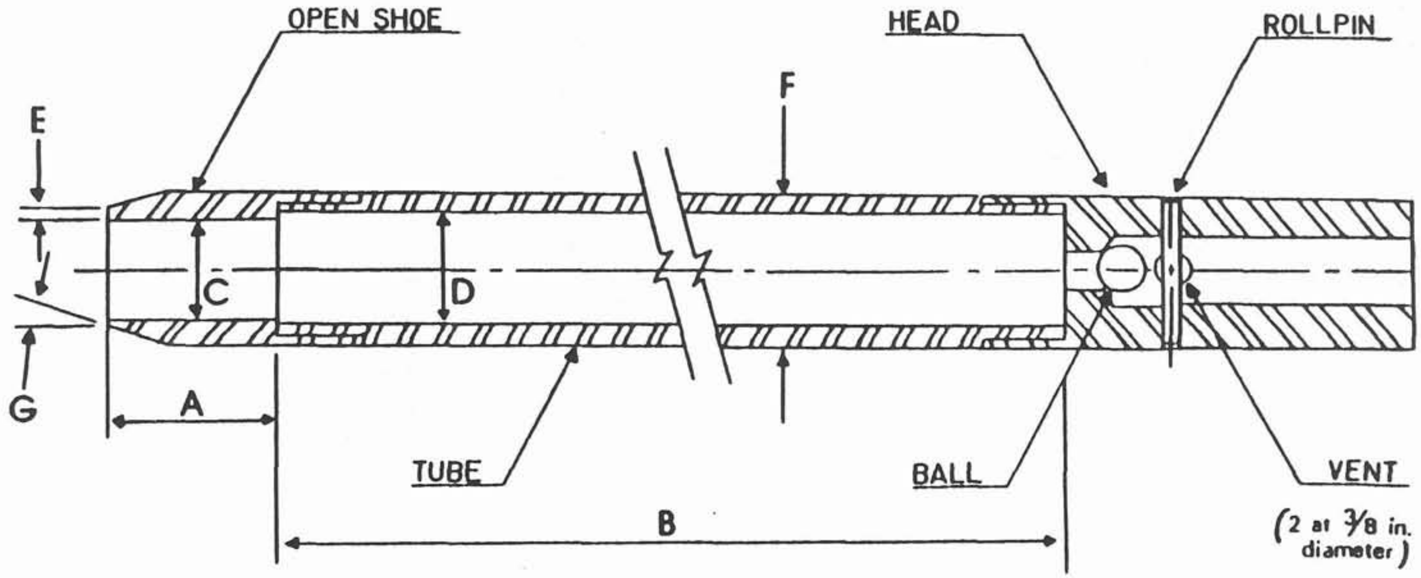


FIG. 1 Definitions of the Number of Rope Turns and the Angle for (a) Counterclockwise Rotation and (b) Clockwise Rotation of the Cathead



A = 1.0 to 2.0 in. (25 to 50 mm)
B = 18.0 to 30.0 in. (0.457 to 0.762 m)
C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
D = 1.50 ± 0.05 − 0.00 in. (38.1 ± 1.3 − 0.0 mm)
E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
F = 2.00 ± 0.05 − 0.00 in. (50.8 ± 1.3 − 0.0 mm)
G = 16.0° to 23.0°

The 1½ in. (38 mm) inside diameter split barrel may be used with a 16-gage wall thickness split liner. The penetrating end of the drive shoe may be slightly rounded. Metal or plastic retainers may be used to retain soil samples.

FIG. 2 Split-Barrel Sampler

CP-00402-3.05-10/1/90

APPENDIX C
SAMPLE SHIPPING PROCEDURES

C.1 INTRODUCTION

Samples collected during field investigations or in response to a hazardous materials incident must be classified by the project leader, prior to shipping by air, as either environmental or hazardous material samples. In general, environmental samples include drinking water, ambient ground and surface water, background/control soils, sediment, treated municipal and industrial wastewater effluents, biological specimens or any samples not expected to be contaminated with high levels of hazardous materials. The shipment of samples designated as environmental samples are not regulated by the U. S. Department of Transportation (US-DOT). However, these samples must be transported in such a manner as to preserve their integrity.

Samples collected from process wastewater streams, drums, bulk storage tanks, or soil, sediment, or water samples from areas suspected of being highly contaminated may need to be shipped as a hazardous material. Regulations for packing, marking, labeling and shipping of hazardous materials and wastes are promulgated by the US-DOT and are described in the Code of Federal Regulations (49 CFR 171 through 177). The guidance for complying with US-DOT regulations in shipping environmental laboratory samples is given in the "National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Environmental Laboratory Samples" (1). Additional guidance is given in a letter to M. D. Lair, P.E., from Thomas J. Charlton, P.E., Chief Standards Division, Office of Hazardous Materials Regulation, Materials Transportation Bureau, US-DOT (2). The transportation of hazardous materials by EPA personnel is covered by EPA Order 1000.18. It is the responsibility of the field project leader to insure that samples classified as hazardous materials are shipped in accordance with these regulations.

C.2 SHIPMENT OF ENVIRONMENTAL SAMPLES

Samples collected by Branch personnel and designated by the project leader as environmental samples shall be shipped using the method described below. However, if the environmental samples are preserved, the amount of preservative must not exceed the amounts indicated in Table 1. If the amount of preservative added to a sample exceeds that listed in Table 1, then that sample may be considered a hazardous material and shall be shipped in accordance with procedures described in 49 CFR 171 through 177. In addition, the shipment of pre-preserved sample containers or bottles of preservatives (i.e., NaOH pellets, HCl, etc.) which are designated as hazardous under the US-DOT, Hazardous Materials Tables, 49 CFR 172.101, must be shipped pursuant to the appropriate US-DOT regulations. The shipment of nitric acid is forbidden on all aircraft.

Environmental samples shall be packed prior to shipment by air using the following procedures:

1. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber tape. Line the cooler with a large heavy duty plastic bag.

2. Allow sufficient outage (ullage) in all bottles (except VOA's) to compensate for any pressure and temperature changes (approximately 10 percent of the volume of the container).

3. Be sure the lids on all bottles are tight (will not leak) and then secure the lid to the bottle with tape (preferably plastic electrical tape) to insure the lid will not vibrate loose during transport.

4. Place all bottles in separate and appropriately sized polyethylene bags and seal the bags with tape (preferably plastic electrical tape).

5. Place four to six VOA vials in a quart metal can and then fill the can with vermiculite.

6. Place two to four inches of vermiculite in the bottom of the cooler and then place the bottles and cans in the cooler with sufficient space to allow for the addition of more vermiculite between the bottles and cans.

7. Put "blue ice" (or ice that has been placed in heavy duty polyethylene bags and properly sealed) on top of or between the samples. Fill all remaining space between the bottles or cans with vermiculite. Securely fasten the top of the large garbage bag with tape (preferably plastic electrical tape).

8. Place chain-of-custody and applicable CLP Traffic Report Forms into the cooler and then close the cooler and securely tape (preferably with fiber tape) the top of the cooler shut. The chain-of-custody seals should be affixed to the top and sides of the cooler so that the cooler cannot be opened without breaking the seal.

9. The shipping containers must be marked "THIS END UP," and arrow labels which indicate the proper upward position of the container should be affixed to the container. A label containing the name and address of the shipper shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo Only Aircraft, Flammable Solids, etc.) are not permitted to be on the outside of the container used to transport environmental samples and shall not be used.

TABLE 1

CHEMICALS LISTED IN THE HAZARDOUS MATERIALS TABLE (49 CFR 172.101)
USED BY ESD FOR PRESERVING SAMPLES

Preservative	Sample Type/ Parameter	pH Recommendation	Quantity of Preservative Added Per Liter	Wt. % of Preservative
HCl	Volatile Organic Analysis	$<2 - \geq 1$	4 drops conc. HCl/40 ml	0.22% (2)
$MgCl_2$	Nitrogen Species	N.A.	40 mg	0.004% (1)
HNO_3	Metals, Hardness	$<2 - \geq 1$	5 ml of conc. (70%)	0.35% (1)
H_2SO_4	Nitrogen Species COD, Oil & Grease, P (hydrolyzable) Organic Carbon, Phenols	$<2 - \geq 1$	2 ml of 36N	0.35% (1)
$NaOH$	Cyanides, Sulfides	$>12 - \leq 13$	2 ml of 10N	0.080% (1)
Freezing* 0°C (Dry Ice)	Biological - Fish & Shellfish Tissue	N.A.	N.A.	N.A.

* - Dry ice is classified as a ORM-A hazard by DOT. There is no labeling requirement for samples preserved with dry ice, but each package must be plainly and durably marked on at least one side or edge with the designation "ORM-A." The package should also be marked "Dry Ice" or "Carbon Dioxide, Solid" and "Frozen Diagnostic Specimens." Samples must be packaged in accordance with the requirements of 49 CFR 173.615 and advance arrangements must be made between the shipper and each carrier.

N.A. - Not applicable.

CP-00402-3.05-10/1/90

C.3 SHIPMENT OF HAZARDOUS MATERIALS SAMPLES

C.3.1 Definitions

The field project leader is responsible for determining if samples collected during a specific field investigation should be classified as hazardous materials. If a sample is collected of a known substance that is listed in the Hazardous Materials Table, 49 CFR 172.101, then that sample must be identified, packaged, marked, labeled, and shipped according to the specified instructions listed for that material. However, if the composition of collected samples are unknown, the project leader must select the appropriate transportation category in accordance with the US-DOT Hazardous Materials Classification (Table 2). In addition, 49 CFR 172.402, Item H, states a material (sample) for which a reasonable doubt exists as to its class and labeling requirements, and for which a sample must be transported for laboratory analysis, may be labeled according to the shipper's tentative class assignment based upon:

- Defining criteria (i.e., definitions of Flammable Liquid, Poison B, etc.),
- The hazard precedence prescribed in 49 CFR 173.2 (Table 2), or
- The shipper's knowledge of the material.

The project leader can utilize data obtained from a photoionization detector or organic vapor analyzer, explosimeter, or radiation survey instruments, as well as pH meter/paper, to help categorize the sample. In general, samples of unknown hazardous materials collected by Branch personnel will be categorized as a Flammable Liquid, Flammable Solid, Corrosive Material, or Poison B. The proper packing, marking, labeling, and shipping procedures for a sample falling into one of these four categories is listed in the Hazardous Materials Table 49 CFR 172.101. It is unlikely that a sample collected by Branch personnel will be classified as a "Poison A." In the event a sample is collected that meets the DOT definition for a "Poison A" (i.e., poisonous gases or liquids of such a nature that a small amount of the gas or vapor of the liquid, mixed with air is dangerous to life - 49 CFR 173.326), that sample shall not be shipped by air cargo. The DOT definitions for Flammable Liquid, Flammable Solid, Corrosive Material, and Poison B are:

C.3.1.1 Flammable Liquid 49 CFR 173.115

1. A flammable liquid means any liquid having a flash point below 100°F (37.8°C) with the following exceptions:

   (a) Any liquid meeting one of the definitions specified in 49 CFR 173.300.

   (b) Any mixture having one component or more with a flash point of 100°F (37.8°C) or higher, that makes up at least 99 percent of the total volume of the mixture.

C.3.1.2 Flammable Solid 49 CFR 173.150

"Flammable Solid" is any solid material, other than one classed as an explosive, which, under conditions normally incident to transportation, is liable to cause fires through friction, retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious transportation hazard. Included in this class are spontaneously combustible and water-reactive materials.

C.3.1.3 Corrosive Material 49 CFR 173.240

1. A corrosive material is a liquid or solid that causes viable destruction or irreversible alterations in human skin tissue at the site of contact, or in the case of leakage from its packaging, a liquid that has a severe corrosion rate on steel.

    (a) A material is considered to be destructive or to cause irreversible alteration in human skin tissue if when tested on the intact skin of the albino rabbit by the technique described in Appendix A to this part, the structure of the tissue at the site of contact is destroyed or changed irreversibly after an exposure period of four hours or less.

    (b) A liquid is considered to have a severe corrosion rate if its corrosion rate exceeds 0.250 inch per year (IPY) on steel (SAE 1020) at a test temperature of 130°F. An acceptable test is described in NACE Standard TM-01-69.

2. If human experience or other data indicate that the hazard of a material is greater or less than indicated by the results of the tests specified in paragraph (a) of this section, the Department may revise its classification or make the material subject to the requirements of Parts 170-189 of this subchapter.

C.3.1.4 Poison B 49 CFR 173.343

1. Class B poisons are those substances, liquid or solid (including pastes and semisolids), other than Class A poisons or irritating materials, which are known to be so toxic to man as to afford a hazard to health during transportation, or which, in the absence of adequate data on human toxicity, are presumed to be toxic to man because they fall within any one of the following categories when tested on laboratory animals:

    (a) Oral Toxicity — Those which produce death within 48 hours in half or more than half of a group of ten or more white laboratory rats weighing 200 to 300 grams at a single dose of 50 milligrams or less per kilogram of body weight, when administered orally.

(b) Toxicity of Inhalation -- Those which produce death within 48 hours in half or more than half of a group of ten or more white laboratory rats weighing 200 to 300 grams, when inhaled continuously for a period of one hour or less at a concentration of 2 milligrams or less per liter of vapor, mist, or dust, provided such concentration is likely to be encountered by man when the chemical product is used in any reasonable foreseeable manner.

(c) Toxicity by Skin Absorption -- Those which produce death within 48 hours in half or more than half of a group of ten or more rabbits tested at a dosage of 200 milligrams or less per kilogram body weight, when administered by continuous contact with the bare skin for 24 hours or less.

2. The foregoing categories shall not apply if the physical characteristics or the probable hazards to humans as shown by experience indicate that the substances will not cause serious sickness or death. Neither the display of danger or warning labels pertaining to use nor the toxicity tests set forth above shall prejudice or prohibit the exemption of any substances from the provisions of Parts 170-189 of this chapter.

C.3.2 Shipping Procedures

The Branch shipping procedures for samples categorized as a limited quantity Flammable Liquid, Flammable Solid, Poison B, or Corrosive Liquid are described below. (Limited quantities for Flammable Liquid, Flammable Solid, Poison B, and Corrosive Liquid are defined in 49 CFR Section 173.118, 173.153, 173.345, and 173.244, respectively). If larger quantities of a sample are required to be shipped than those listed (i.e., more than an 8-ounce container/sample or as specified below) then the limited quantity shipping procedures may not apply, and the project leader shall refer to the US-DOT regulations for the proper shipping procedures.

C.3.2.1 Flammable Solid or Flammable Liquid

1. Collect sample in an 8-ounce glass container (or see Appendix A to determine the appropriate containers). Allow sufficient ullage (approximately 10 percent by volume) so container is not liquid full at 130°F. If collecting a solid material, the container plus contents shall not exceed one pound net weight.

2. Attach properly completed Sample Tag (see Section 3) to sample container.

3. Be sure the lids on all bottles are tight (will not leak) and then secure the lid to the bottle with tape (preferably plastic electrical tape). Place a custody seal across the lid of the sample container and place the container in a 2-mil-thick (or thicker) polyethylene bag, one sample per bag. Seal the bag with tape (preferably plastic electrical tape). Tags should be positioned to enable them to be read through bag.

4. Place sealed bag inside a metal can with incombustible, absorbent cushioning material (e.g., vermiculite or diatomaceous earth) to prevent breakage (one bag per can). Pressure-close the can and use clips, tape, or other positive means to hold the lid securely, tightly, and effectively.

5. Mark and label the container as indicated in No. 8 below.

6. Place one or more metal cans surrounded with incombustible packaging material for stability during transport, into a strong outside container, such as a metal picnic cooler or a fiberboard box.

7. Mark and label the outside shipping container and complete shipping papers as described below.

8. Marking and Labeling: Use abbreviations only where specified. Place the following information on the shipping container, either hand printed or in label form: laboratory name and address and "Flammable Liquid, N.O.S.," UN 1993 or "Flammable Solid, N.O.S.," UN 1325. Place the following labels on the outside of the container.

   "Cargo Aircraft Only"; "Flammable Liquid"; if not liquid, "Flammable Solid" ("Dangerous When Wet" label should be used if the solid has not been exposed to wet environment).

   NOTE: If the cans are placed in an exterior container, both that container and inside cans must have the same markings and labels as above. "Laboratory Samples" and "THIS SIDE UP" or "THIS END UP" should also be marked on the top of the exterior container, and upward pointing arrows should be placed on all four sides of the exterior container.

   Shipping Papers: Use abbreviations only where specified below.

   Complete the carrier-provided Bill of Lading and sign the certification statement (if carrier does not provide, use standard industry form) with the following information in the order listed. One form may be used for more than one exterior container.

   "Flammable Liquid, N.O.S." UN1993 (or "Flammable Solid, N.O.S." UN1325, as appropriate); "Cargo Aircraft Only"; "Limited Quantity" or Ltd. Qty."; "Laboratory Samples"; "Net Weight ________" or "Net Volume ________" (of hazardous contents), by item, if more than one metal can is inside an exterior container. The net weight or net volume must be placed just before or just after the "Flammable Liquid, N.O.S." or "Flammable Solid, N.O.S."

A Chain-of-Custody Record form (see Section 3) should also be properly executed and included in the exterior container.

9. A team member must accompany shipping container(s) to the transport carrier and, if required, open outside container(s) for air freight inspection.

C.3.2.2 Flammable Liquid, Multi Class or Single Class, Greater Than One Pint Containers; or Poison B, Liquid; or Poison B, Solid. (Note: Package re- requirement for multiclass flammable liquids also meets the requirements for Poison B liquids and solids.)

1. Collect sample in an 8-ounce glass container (or see Appendix A to determine the appropriate containers). Allow sufficient ullage (approximately 10 percent by volume) so container is not liquid full at 130°F. If collecting a solid material, the container plus contents shall not exceed five pounds net weight.

2. Attach properly completed sample tag (see Section 3) to sample container.

3. Be sure the lids on all bottles are tight (will not leak) and then secure the lid to the bottles with tape (preferably plastic electrical tape). Place a custody seal across the lid of the sample container and place the container in a 2-mil-thick (or thicker) polyethylene bag (one sample per bag). Seal the bag with tape (preferably plastic electrical tape). Tags should be positioned to enable them to be read through bag.

4. Place sealed bag inside a one-quart metal can with incombustible, absorbent cushioning material (e.g., vermiculite or diatomaceous earth) to prevent breakage (one bag per can). Pressure-close the can and use clips, tape, or other positive means to hold the lid securely, tightly, and effectively.

5. Mark and label the container as indicated in No. 8 below.

6. Place the one-quart metal can or cans in a *DOT* 12B fiberboard box using styrofoam headers to avoid movement of the can/cans. Specially designed boxes which provide an exact fit for the can/cans and headers must be used.

7. Mark and label the outside container and complete shipping papers as described below.

8. Place the following information on the metal can (or bottle) and exterior shipping container, either hand printed or in label form: laboratory name and address and proper shipping name (i.e., "Poison B, Liquid, N.O.S" UN 2810, etc.). Place the following labels on the outside of the metal can (or bottle) and the exterior container:

   "Cargo Aircraft Only"; proper label for hazard class (i.e., "Poison" UN 2810, etc.). "Dangerous When Wet" label should be used if the solid has not been exposed to a wet environment.

Note: "Laboratory Samples" and "THIS SIDE UP" or "THIS END UP" should also be marked on the top of the exterior container and upward pointing arrows should be placed on all four sides of the exterior container.

Shipping Papers: Use abbreviations only where specified below.

Complete the carrier-provided Bill of Lading and sign the certification statement (if carrier does not provide, use standard industry form) with the following information in the order listed. One form may be used for more than one exterior container.

Proper shipping name ("Poison B, Liquid, N.O.S." UN 2810, etc.), "Cargo Aircraft Only"; "Laboratory Samples"; "Net Weight ______" or "Net Volume _____" (of hazardous contents), by item, if more than one metal can is inside an exterior container. The net weight or net volume must be placed just before or just after the proper shipping name.

A Chain-of-Custody Record form (see Section 3) should also be properly executed, and included in the exterior container.

9. A team member must accompany shipping container(s) to the transport carrier and, if required, open outside container(s) for freight inspection.

When containers greater than 8-ounce capacity must be shipped, the above procedures will be used with the following modifications:

1. One-gallon or smaller glass or plastic containers will be used to collect the sample (see Appendix B to determine the proper container).

2. The container will then be placed directly into a DOT 15A wooden box (not more than two containers to each box), separated with foam or styrofoam padding and the remainder of the box filled with incombustible, absorbent cushioning material (e.g., vermiculite or diatomaceous earth).

(Note: If a sample is designated as a Poison B material and shipped by Federal Express, it must be packed in accordance with the exemption packing procedures as shown in the example given in Exhibit A.)

C.3.2.3 Corrosive Liquid/Corrosive Solid

1. Collect sample in an 8-ounce glass container (see Appendix A to determine the appropriate containers). Allow sufficient ullage (approximately 10 percent by volume) so container is not liquid full at 130°F. If collecting a solid material, the container plus contents shall not exceed one pound net weight.

2. Attach properly completed sample tag (see Section 3) to sample container.

3. Be sure the lids on all bottles are tight (will not leak) and then secure the lid to the bottle with tape (preferably plastic electrical tape). Place a custody seal across the lid of the sample container and place the container in a 2-mil-thick (or thicker) polyethylene bag (one sample per bag). Seal the bag with tape (preferably plastic electrical tape). Tags should be positioned to enable them to be read through bag.

4. Place sealed bag inside a metal can with incombustible, absorbent cushioning material (e.g., vermiculite or diatomaceous earth) to prevent breakage (one bag per can). Pressure-close the metal can and use clips, tape or other positive means to hold the lid securely, tightly, and effectively.

5. Mark and label the container as indicated in No. 8 below.

6. Place one or more metal cans surrounded with incombustible packaging material for stability during transport, into a strong outside container, such as a metal picnic cooler or a fiberboard box.

7. Mark and label the outside container and complete shipping papers as described below.

8. Marking and Labeling: Use abbreviations only where specified. Place the following information on the metal can (or bottle), either hand printed or in label form: laboratory name and address and "Corrosive Liquid, N.O.S." UN 1760 or if not liquid, "Corrosive Solid, N.O.S." UN 1759. Place the following labels on the outside of the can (or bottle).

   "Cargo Aircraft Only"; "Corrosive Liquid"; if not liquid, "Corrosive Solid".

   NOTE: If the cans are placed in an exterior container, both that container and inside cans must have the same markings and labels as above. "Laboratory Samples" and "THIS SIDE UP" or "THIS END UP" should also be marked on the top of the exterior container, and upward pointing arrows should be placed on all four sides of the exterior container.

   Shipping Papers: Use abbreviations only where specified below.

   Complete the carrier-provided Bill of Lading and sign the certification statement (if carrier does not provide, use standard industry form) with the following information in the order listed. One form may be used for more than one exterior container.

   "Corrosive Liquid, N.O.S." UN 1760 (or "Corrosive Solid, N.O.S." UN 1759 as appropriate); "Cargo Aircraft Only"; "Limited Quantity" or "Ltd. Qty."; "Laboratory Samples"; "Net Volume ______" or "Net Weight ______" (of hazardous contents), by item, if more than one metal can is inside an exterior container. The net weight or net volume must be placed just before or just after the "Corrosive Liquid, N.O.S." UN 1760 or "Corrosive Solid, N.O.S." UN 1759.

A Chain-of-Custody Record form (see Section 3) should also be properly executed and included in the exterior container.

9. A team member must accompany shipping container(s) to the transport carrier and, if required, open outside container(s) for freight inspection.

TABLE 2
DOT HAZARDOUS MATERIAL CLASSIFICATION (49 CFR 173.2)

1. Radioactive material
2. Poison A
3. Flammable gas
4. Non-flammable gas
5. Flammable liquid
6. Oxidizer
7. Flammable solid
8. Corrosive material (liquid)
9. Poison B
10. Corrosive material (solid)
11. Irritating material
12. Combustible liquid (in containers having capacities exceeding 110 gallons)
13. ORM-B
14. ORM-A
15. Combustible liquid (in containers having capacities of 110 gallons or less)
16. ORM-E

D.O.T. APPROVED POISON EXEMPT PACKAGING

EXHIBIT A
EXAMPLE OF POISON B EXEMPT PACK

MAX FESSLER
VICE PRESIDENT SALES

Lawrence
PACKAGING SUPPLY CORP

113 NORTH 13TH STREET, NEWARK, N. J. 07107
(201)
N. Y. (212) 962-4294

Lawrence
PACK.
SUPPL

113 NORTH 13TH STREET NEWARK
20

6832 WATCHER ST COMMERCE
(213

EXHIBIT A CONTINUED

PACKAGE No. 37

For 16-Oz. Liquids
and 32 Oz. Liquids

DESIGNED FOR THE TRANSPORT OF LIQUID POISONS.

PACKAGE No. 37A*

For 1 Pound Solids
and 3 Pound Solids

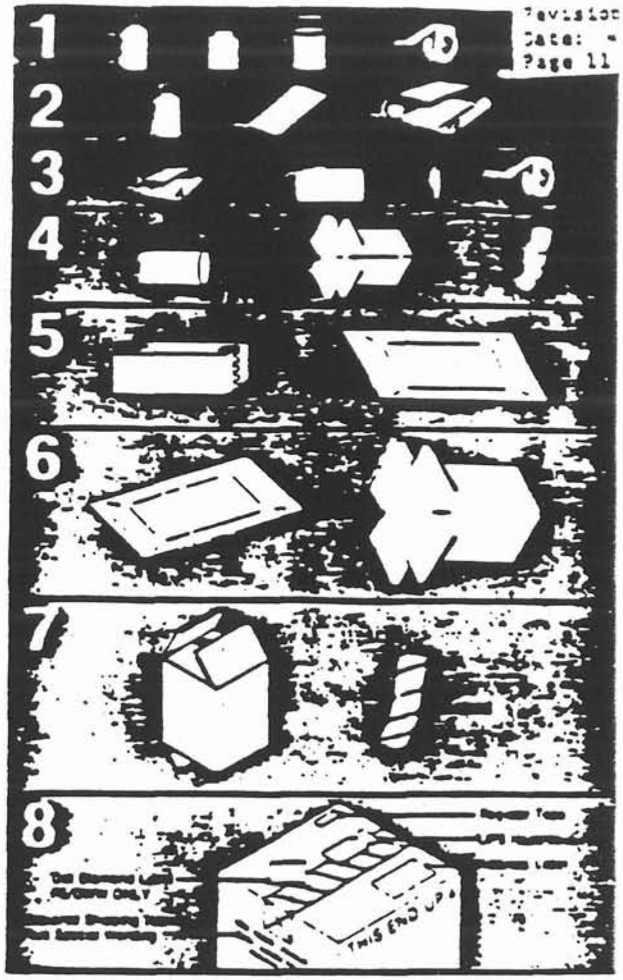
CONSTRUCTED TO ACCOMMODATE SOLID POISONS AND FLAMMABLE SOLIDS THAT ARE DANGEROUS WHEN WET.

*PACKAGE NO. 37A — SLIP COVER CAN IS NOT REQUIRED

PACKAGE NO. 39

Radioactive Type A
Quantity Only

REFER TO U P S HAZARDOUS MATERIAL GUIDE FOR PROPER MARKING AND LABELING OF PACKAGE NO. 39



Inside Container	Tightly closed glass bottle cap sealed with 1" pressure sensitive tape, not over one liter capacity
Intermediate Container	Place bottle in heat sealed barrier bag to meet commercial equivalent of MIL-B-117 Type I Class E Style I, then heat seal bag closed
Cushioning	Wrap bagged bottle with creped cellulose wadding sufficient to absorb content of bottle and sufficient to fill following can
Intermediate Container	Place bagged and wrapped bottle in 80 pound slip cover can. Seal the can closed with band of 1" pressure sensitive tape
Intermediate Container	Place assembly above in 275 pound test single wall regular slotted carton
Intermediate Sealing	Tape carton closed using two strip method with 3" water activated reinforced kraft tape
Intermediate Container	Place boxed assembly above in heat sealed barrier bag to meet commercial equivalent of MIL-B-117 Type I Class E Style I. Then heat seal bag closed
*Outside Container	Place assembly(s) above into tight fitting 600 pound test, double wall regular slotted carton
Sealing	Tape carton closed using only two strip method with 3" water activated reinforced kraft tape
Labeling and Marking	1 DOT (diamond) label NOT required 2 DOT cautionary markings (if applicable) 3 UPS 5-part Hazardous Material form 4 Address label (Stenciling on packaging not permitted) 5 Shipper number or register tag 6 Required DOT shipping name on outside container plus wording "NO DOT LABEL REQUIRED [redacted] DOT E-8249 Labeling of packages should be done with most stable orientation up. Shipping labels should be placed on the top surface of the pack only

*[illegible]

**[illegible]

***[illegible]

[illegible]
[redacted] DOT E-8249

[illegible]

C.4 REFERENCES

1. "Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples," Memo from David Weitzman, Work Group Chairperson, Office of Occupational Health and Safety (PM-273), US-EPA, April 13, 1981.

2. Letter from Thomas J. Charlton, P.E., Chief, Standards Division, Office of Hazardous Materials Regulation, Materials Transportation Bureau, US-DOT to Myron D. Lair, P.E., Chief, Hazardous Waste Section, ESB, ESD, Region IV, US-EPA, March 22, 1985.

APPENDIX A-2

EXAMPLE FORMS

TABLE OF CONTENTS
APPENDIX A-2

NUS CORPORATION	CHAIN OF CUSTODY RECORD

PROJECT NO.:

SITE NAME:

SAMPLERS (SIGNATURE):

STATION NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS							REMARKS

RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE).	DATE/TIME.	RECEIVED BY (SIGNATURE).
RELINQUISHED BY (SIGNATURE):	DATE/TIME:	RECEIVED BY (SIGNATURE):	RELINQUISHED BY (SIGNATURE)	DATE/TIME.	RECEIVED BY (SIGNATURE)
RELINQUISHED BY (SIGNATURE).	DATE/TIME.	RECEIVED FOR LABORATORY BY (SIGNATURE):	DATE/TIME:	REMARKS.	

NUS 440 34 0484

CP-00402-3.05-10/1/90

CP-00402-3.05-10/1/90

ATTACHMENT B-8

NUS CORPORATION
A Halliburton Company

SAMPLE LOG SHEET

- [ ] Surface Soil
- [ ] Subsurface Soil
- [ ] Sediment
- [ ] Lagoon / Pond
- [ ] Other ____________

Page _____ of _____

Case # ____________

By ____________

Project Site Name ____________ Project Site Number ____________

NUS Source No. ____________ Source Location ____________

	Composite Sample Data		
Sample Method:	Sample	Time	Color Description
Depth Sampled:			
Sample Date & Time:			
Sampled By:			
Signature(s):			
Type of Sample [ ] Low Concentration [ ] High Concentration [ ] Grab [ ] Composite [ ] Grab - Composite			
	Sample Data		
	Color	Description: (Sand, Clay, Dry, Moist, Wet, etc.)	

Analysis:	Observations / Notes

		Organic	Inorganic
	Traffic Report #		
	Tag #		
	AB #		
	Date Shipped		
	Time Shipped		
	Lab		
	Volume		

EQUIPMENT CALIBRATION LOG

Instrument (Name/Model No./Serial No.): ______________________________

Manufacturer ______________________ **Date Purchased** ______________

Calibration Date	Initial Settings	Standard/Gas Used	Procedure	Adjustments Made	Final Settings	Signature	Comments

ATTACHMENT D-1

DAILY ACTIVITIES RECORD - FIELD INVESTIGATION	NUS CORPORATION

PROJECT NAME: ______ PROJECT NO ______
CLIENT ______ LOCATION ______
DATE: ______ ARRIVAL TIME: ______ DEPARTURE TIME ______
CONTRACTOR: ______ DRILLER: ______
BORING NO: ______ NUS REPRESENTATIVE: ______

ITEM (1)	ORIGINAL QUANTITY (2) ESTIMATE	QUANTITY (2) TODAY	PREVIOUS TOTAL (2) QUANTITY	CUMULATIVE QUANTITY (2) TO DATE
1. Mobilization/Demobilization	Job			
2. Overburden Drilling/Sampling, minimum 6-inch	100 ft.			
3. Overburden Drilling, 10-inch	250 ft.			
4. Overburden Drilling 14-inch	450 ft.			
5. Bedrock Drilling 6-inch	530 ft.			
6. Bedrock Drilling 10-inch	550 ft.			
7. Bedrock Drilling 14-inch	150 ft.			
8. Temporary 6-inch Steel Casing	250 ft.			
9. Temporary 10-inch Steel Casing	200 ft.			
10. Temporary 14-inch Steel Casing	250 ft.			
11. Permanent 6-inch Steel Casing	1,250 ft.			
12. Permanent 10-inch Steel Casing	400 ft.			
13. PVC Well Construction/Installation	1,120 ft.			
14. Mine Void Sealing	8			
15. Boring Backfilling	NA			
16. Well Development	24 hrs.			
17. Test Borings	200 ft.			
18. Test Pit Excavation	50 hrs.			
19. Standby	20 hrs.			

COMMENTS: ______

(1) AS LISTED IN SPECS
(2) INCLUDE QUANTITY AND UNITS
(Ex. 20 ft., 6 hrs.)

APPROVED BY:

______
NUS FIELD REPRESENTATIVE

______
DRILLER OR REPRESENTATIVE

ATTACHMENT A

SOIL TERMS

UNIFIED SOIL CLASSIFICATION (USCS)

COARSE GRAINED SOILS

More than half of material is LARGER than No. 200 sieve size

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights)			GROUP SYMBOL	TYPICAL NAMES
GRAVELS	CLEAN GRAVELS	Wide range in grain size and substantial amounts of all intermediate particle sizes	GW	Well graded gravels, gravel sand mixtures, little or no fines
		Predominantly one size or a range of sizes with some intermediate sizes missing	GP	Poorly graded gravels, gravel sand mixtures, little or no fines
	GRAVELS W/FINES	Non plastic fines (for identification procedures see ML)	GM	Silty gravels, poorly graded gravel sand silt mixtures
		Plastic fines (for identification procedures see CL)	GC	Clayey gravels, poorly graded gravel sand clay mixtures
SANDS	CLEAN SANDS	Wide range in grain size and substantial amounts of all intermediate particle sizes	SW	Well graded sand, gravelly sands, little or no fines
		Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Poorly graded sands, gravelly sands, little or no fines
	SANDS W/FINES	Non plastic fines (for identification procedures see ML)	SM	Silty sands, poorly graded sand silt mixtures
		Plastic fines (for identification procedures see CL)	SC	Clayey sands, poorly graded sand clay mixtures

FINE GRAINED SOILS

More than half of material is SMALLER than No. 200 sieve size

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 3" & basing fractions on estimated weights)				GROUP SYMBOL	TYPICAL NAMES
Identification procedures on fraction smaller than No. 40 sieve size					
	DRY STRENGTH (Crushing characteristics)	DILATANCY (Reaction to shaking)	TOUGHNESS (Consistency near plastic limit)		
SILTS & CLAYS Liquid limit < 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity
	Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
	Slight to medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity
SILTS & CLAYS Liquid limit > 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays
	Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity
HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel and frequently by fibrous texture			Pt	Peat and other organic soils

Boundary classifications: Soils possessing characteristics of two groups are designated by combining group symbols. For example GW-GC, well graded gravel sand mixture with clay binder.
All sieve sizes on this chart are U.S. standard

DENSITY OF GRANULAR SOILS

DESIGNATION	STANDARD PENETRATION RESISTANCE - BLOWS/FOOT
Very loose	0-4
Loose	5-10
Medium dense	11-30
Dense	31-50
Very dense	Over 50

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNC. COMPRESSIVE STR. TONS/SQ. FT.	STANDARD PENETRATION RESISTANCE - BLOWS/FOOT	FIELD IDENTIFICATION METHODS
Very soft	Less than 0.25	0 to 2	Easily penetrated several inches by fist
Soft	0.25 to 0.50	2 to 4	Easily penetrated several inches by thumb
Medium stiff	0.50 to 1.0	4 to 8	Can be penetrated several inches by thumb
Stiff	1.0 to 2.0	8 to 15	Readily indented by thumb
Very stiff	2.0 to 4.0	15 to 30	Readily indented by thumbnail
Hard	More than 4.0	Over 30	Indented with difficulty by thumbnail

ROCK TERMS

ROCK HARDNESS (FROM CORE SAMPLES)

DESCRIPTIVE TERMS	SCREWDRIVER OR KNIFE EFFECTS	HAMMER EFFECTS
Soft	Easily gouged	Crushes when pressed with hammer
Medium soft	Can be gouged	Breaks (one blow) Crumbly edges
Medium hard	Can be scratched	Breaks (one blow) Sharp edges
Hard	Cannot be scratched	Breaks conchoidally (several blows) Sharp edges

ROCK BROKENNESS

DESCRIPTIVE TERMS	ABBREVIATION	SPACING
Very broken	(V. Br.)	0-2"
Broken	(Br.)	2"-1'
Blocky	(Bl.)	1'-3'
Massive	(M.)	3'-10'

LEGEND

SOIL SAMPLES - TYPES

S - 2" O.D. Split Barrel Sample
ST - 3" O.D. Undisturbed Sample
O - Other Samples, Specify in Remarks

ROCK SAMPLES - TYPES

X - NX (Conventional) Core (- 2-1/8" O.D.)
Q - NQ (Wireline) Core (- 1-7/8" O.D.)
Z - Other Core Sizes, Specify in Remarks

WATER LEVELS

12/18
▽ 12.6 Initial Level w/Date & Depth

12/18
▼ 12.6' Stabilized Level w/Date & Depth

ATTACHMENT C-3

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET **NUS CORPORATION**

PROJECT NAME: WELL/BORING NO.:
PROJECT NO.: GEOLOGIST:
WELL DIAMETER: SCREEN LENGTH/DEPTH: / TEST NO.:
STATIC WATER LEVEL (Depth/Elevation): / DATE:
TEST TYPE (Rising/Falling/Constant Head): CHECKED:
METHOD OF INDUCING WATER LEVEL CHANGE: PAGE ___ OF ___

TIME	ELAPSED TIME (min. or sec.)	MEASURED DEPTH TO WATER (ft.)	CORRECTION	DEPTH TO WATER (ft.)	DRAWDOWN OR HEAD (ft.)	REMARKS

1ac 5/88

APPENDIX B

HEALTH AND SAFETY PLAN

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLES

FIGURES

1.0 KEY PERSONNEL
HEALTH AND SAFETY PLAN BACKGROUND

Site Name: MCAS, Cherry Point

Address: Marine Corps Air Station
Cherry Point, North Carolina

Client Contact: Nina Johnson (Navy)
Phone No.: (804) 445-6643
Site Contact: George Radford (MCAS, Cherry Point)
Phone No.: (919) 466-3631
Phone No.: ______

Date Plan Requested: August 8, 1990

Purpose of Site Visit: Install monitoring wells; take groundwater samples, drill soil borings, and conduct slug tests, take surface water and sediment samples.

Proposed Date of Work: ______

Proposed Site Investigation Team:

Personnel:	Discipline/Tasks Assigned:
Debbie Wroblewski	NUS Project Manager,
Linda Klink	Project Engineer
Stan Conti	Field Operations Leader (FOL)
Alan Margraf	Health and Safety Officer

Other:	Purpose:

Plan Preparation:

Prepared by: Alan Margraf (08/10/90)

Reviewed and Approved by: ______ (__/__/__)

Reviewed:

NUS Project Manager: ______

Follow Up Report:

Responsible Person: ______

(Must fill out Follow Up Report)

2.0 SITE BACKGROUND

2.1 FACILITY DESCRIPTION

Cherry Point is a Marine Corps Air Station covering approximately 11,704 acres and is located in Craven County, North Carolina. Cherry Point maintains and operates support facilities and provides services and materials for the tenants of the station.

2.2 PRINCIPAL DISPOSAL METHOD

The Department of the Navy, owner/operator of the Marine Corps Air Station, engages in the generation, treatment, storage, and disposal of hazardous waste at the Cherry Point facility. Various disposal methods such as incinerators and landfills, as well as numerous other solid and hazardous waste management units including treatment plants, accumulation areas, storage areas, etc., are/were utilized on site. A list and description of each one of the units and other potential contamination sources can be found in Section IV of the Administrative Order On Consent (Consent Agreement), EPA identification number NCI 170 027.261.

2.3 STATUS

MCAS, Cherry Point is an active treatment, storage, and disposal (TSD) facility engaging in various activities involving hazardous materials/wastes.

2.4 HISTORY

The Department of the Navy, owner/operator of the facility, was previously conducting an Installation Restoration (IR) Program at the facility. The first phase of the IR Program identified suspected sites of contamination and was completed in 1983. The following ongoing phase consisted of investigative activities which resulted in a Remedial Investigation (RI) Interim Report in October 1988. In June 1988, EPA contractor A. T. Kearney, Inc., submitted a RCRA Facility Assessment Report (RFA) which identified over 100 Solid Waste Management Units (SWMUs) and two other areas of concern. In December 1989, a RCRA Consent Agreement was signed between the EPA and the Department of Defense. Thirty-two Solid Waste Management Units (SWMUs) were listed in the Consent Agreement. Phase I RFI activities are described in this FOP. The four SWMU's covered in this HASP are 5, 10, 16, and 17.

2.5 PERSONAL PROTECTION USED ON PREVIOUS SITE VISITS

The only level of protection known to have been worn at MCAS, Cherry Point is Level D. Level D protection was worn during the Installation Restoration Program at the Marine Corps Auxiliary Landing Field in December 1988. Operations included the installation of monitoring wells and various soil and water sampling activities. Level D was also worn by NERI personnel during a soil gas survey conducted at the MCAS, Cherry Point in October 1989.

3.0 SCOPE OF WORK

A RCRA Facility Investigation (RFI) will be conducted focusing on sampling and analytical efforts that will provide data to define present and future risks to human health and the environment as well as to evaluate potential remedial alternatives.

Four RFI Units (5, 10, 16 and 17) at MCAS, Cherry Point are included in the FOP. Planned activities at these four sites include survey work, installation of monitoring wells, drilling soil borings, taking water level measurements, conducting slug tests, groundwater sampling, resampling existing monitoring wells, taking surface water and sediment samples.

A complete description of the scope of work for activities at each RFI Unit can be found in the FOP.

4.0 RISK ANALYSIS

4.1 CHEMICAL HAZARDS

Work activities include the installation of monitoring wells, placement of soil borings, slug tests, and groundwater sampling at each of the four sites (Units 5, 10, 16 and 17). Previous studies have provided analytical data concerning contamination known to be present at these particular sites. Table 4-1 outlines some of the substances detected in previous analyses.

The primary hazard, although minimal, associated with this investigation will be dermal contact and inhalation exposure with the waste/contamination in general. Many of the contaminants are irritants; other cause headaches, nausea, drowsiness, abdominal pain, CNS depression; and many are experimental or suspected carcinogens, although these effects are not expected based upon the concentrations of contaminants expected to be encountered. Many of these substances can enter the body via all routes; therefore, proper PPE must be worn. Table 4-1 presents the known or suspected chemical substances which could be encountered at any of one or all of the RFI units. Since past analytical data is limited, the table may not be all inclusive. Secondary concerns include inhalation exposure to the various forms of metals and ingestion of site contaminants. One other potential hazard would be the generation of a flammable or oxygen deficient atmosphere that could exist as a result of emissions from bore holes.

Level D personal protective equipment should provide adequate protection against dermal contact; however, Level C may be required if dusty conditions become evident and cannot be controlled via other control measures (e.g., wetting down areas of concern).

The use of real time air monitoring instruments, visual observation, and olfactory observation will help to identify inhalation exposures to site contaminants. Personal protective equipment (PPE) and NUS standard operating procedures will be used, when necessary, to help reduce or eliminate exposures and therefore reduce the potential for adverse health effects.

TABLE 4-1

PROTECTION AGAINST POTENTIAL HAZARDS
MCAS, CHERRY POINT, NORTH CAROLINA

Substance	CAS Number	In Sample (soil, water, air, waste)	Toxicity			C
			SEL	Route of Exposure	Comments and Symptoms	
Trichloroethene	79-01-6	Groundwater	50 ppm	Inhalation Ingestion	• Eye and skin irritant • Headaches, drowsiness	Yes
Trans-1,2-dichloroethene	156-60-5	Groundwater	200ppm	Inhalation Ingestion Contact	• Ether-like odor • Irritating to skin and eyes • Central nervous system toxin • May cause nausea and vomiting	No
Vinyl chloride	75-01-4	Groundwater	1 ppm	Inhalation	• Weakness, abdominal pain • Gastrointestinal bleeding	Yes
Arsenic	7740-38-2	Surface water and sediment	2 $\mu g/m^3$	Inhalation Absorption Contact Ingestion	• Dermatitis • Gastrointestinal disturbances • Respiratory irritation	Yes
Copper	7440-50-8	Surface water and sediment	1 mg/m^3	Inhalation Ingestion Contact	• Irritation to mucous membranes • Nasal perforation • Eye irritation, metal taste	No
Zinc	7440-66-6	Surface water and sediment	N/A	Inhalation Ingestion	• Irritation to eyes, nose, throat • Sweet taste, cough, chills, nausea, vomiting	No
Chromium	7440-47-3	Surface water and sediment	0.5 mg Cr/m^3	Inhalation Ingestion	• Histologic fibrosis of lungs • Target organ: respiratory system	Yes
Cadmium	7440-43-9	Surface water and sediment	0.2 mg/m^3	Inhalation Ingestion	• Pulmonary edema • Cough, tight chest, headache • Chills, nausea, anemia	Yes
Lead	7439-92-1	Surface water, groundwater, sediment	0.05 mg/m^3	Inhalation Ingestion Contact	• Insomnia, anemia, constipation • Abdominal pain, hypertension	No
Nickel	7440-02-0	Surface water and sediment	1 mg/m^3	Inhalation Ingestion Contact	• Sensitization dermatitis • Asthma	yes

TABLE 4-1
PROTECTION AGAINST POTENTIAL HAZARDS
MCAS, CHERRY POINT, NORTH CAROLINA
PAGE TWO

Substance	CAS Number	In Sample (soil, water, air, waste)	Toxicity			C
			SEL	Route of Exposure	Comments and Symptoms	
Phenolics	108-95-2	Sediment Groundwater	5 ppm	Inhalation Ingestion Absorption Contact	• Sweet, tarry odor • Irritating to eyes, nose, throat • Weakness, dark urine	No
Chloroform	67-66-3	Surface water	2 ppm	Inhalation Ingestion Contact	• Pleasant, sweet odor • Dizziness, nausea, headache, fatigue, eye and skin irritant	Yes
1,1,1-TCA	71-55-6	Surface water	1 ppm	Ingestion	• Irritant to skin and eyes and mucous membranes	No
Toluene	108-88-3	Surface water	100 ppm	Inhalation Ingestion Absorption Contact	• Aromatic odor like benzene • Symptoms include fatigue, weakness, confusion, headache	No
Bromodichloromethane	75-27-4	Surface water		Ingestion	• Irritating and narcotic effects	No
Chlorodibromomethane	124-48-1	Surface water		Ingestion	• Irritating and narcotic effects	Yes
N-nitrosodiphenylamine	86-30-6	Groundwater		Ingestion	• Experimental carcinogen • Eye irritant	Yes
1,1,1-Trichloroethane	76-03-9	Groundwater	350 ppm	Inhalation Ingestion Absorption Contact	• Nausea, vomiting, diarrhea • Hallucinations, irritability	No
1,1-Dichloroethane	75-34-3	Groundwater	100 ppm	Inhalation Ingestion Contact	• Irritating to skin and eyes • CNS toxin • May produce irregular heartbeat	No

CAS Number: Chemical Abstract Service Identification Number.
SEL: The lowest of the three safe exposure limits (SEL) established by OSHA-PELs, NIOSH-RELs, or ACGIH-TLVs presented in parts per million.
C: Data indicating potential carcinogenic effects.

4.2 PHYSICAL HAZARDS

Aside from the hazards presented by chemical substances, physical hazards must also be addressed. Physical hazards could involve the following items:

- Contact with energized sources
- Exposure to moving machinery, particularly during drilling activities
- Uneven or unstable terrain (slip, trip hazards)
- Manual lifting technique
- Noise in excess of 85 dBA
- Falls from elevated surfaces

Control efforts for these potential hazards include requirements that machinery on site (i.e., drill rigs) be kept properly maintained, positioned, guarded, and operated. No drilling masts or any other such projecting items shall be permitted within a 20-foot radius of energized sources. Also, any areas targeted for subsurface investigation shall first be investigated to determine the presence of underground utilities.

Personnel are to be advised of hazards from contact with moving machinery pinch points. Protective gear must fit properly and be taped, not only to minimize chemical exposure, but also to minimize potential entanglement with moving machinery. Additionally, equipment will be shut down and locked out before maintenance functions are performed. To protect against overhead hazards, personnel are to wear hard hats when required.

During lifting tasks, personnel are to lift with the force of the load carried by their legs and not by their backs. An appropriate number of personnel must be used when lifting or handling heavy equipment. These procedures are to be employed to minimize the potential for back strain.

The HSO will make a decision regarding the need to perform a noise survey of operations. In any event, ear protection will be available on site.

5.0 PERSONNEL PROTECTIVE EQUIPMENT (PPE)

5.1 PPE REQUIREMENTS

All tasks require the use of hard hats, safety glasses, and steel toe work boots, as a minimum.

Drillers and helpers must wear boot covers, surgical inner gloves, nitrile outer gloves, Tyvek coveralls, and taped ankles and wrists during installation of groundwater monitoring wells, in addition to the minimum requirements presented above.

Persons involved in groundwater, and/or surface water/sediment sampling are required to wear boot covers, inner surgical gloves, and nitrile outer gloves in addition to the minimum requirements presented above.

Persons handling chemicals including detergent/water solutions, for decontamination of sampling tools, are required to wear surgical inner gloves, nitrile outer gloves, and chemical splash goggles.

Persons involved in decontamination of drilling equipment--to include the rig, associated pipe, and augers--are required to wear PVC coveralls with hoods, surgical inner gloves, nitrile outer gloves, boot covers, taped ankle and wrist joints, and splash shields in addition to the minimum requirements stipulated above.

5.2 PPE SELECTION CRITERIA

Hard hats, safety glasses, and steel toe and shank work boots were selected as minimum protection to reduce the potential for injury, resulting from exposure to the physical hazards associated with drilling operations.

Boot covers, chemical resistant gloves, and Tyvek coveralls were selected to minimize contamination of work clothes and to prevent direct skin contact with potential site contaminants.

PVC coveralls and splash shields were selected to prevent saturation of work clothes during decontamination activities where large volumes of liquid can be encountered, as well as to protect the face from splashing liquids or overspray which could potentially be contaminated.

5.3 PPE MODIFICATION CRITERIA AND ACTION LEVELS

Tyvek coveralls and boot covers must be worn for any task which involves a reasonable potential for contamination of work clothes.

If positive HNU readings are observed above background levels in the workers' breathing zone or if odors are present or if any adverse health effects are noted during work, workers must immediately withdraw from the affected area and notify the NUS HSO and project manager.

If, during the projected work, dusty conditions arise, full-face respirators with dust cartridges are to be utilized. This will prevent inhalation of particulates, which may contain heavy metals suspected to be onsite.

5.4 PERSONAL PROTECTIVE EQUIPMENT DESCRIPTIONS

Level C protection should be selected when the type of hazardous airborne substance is known, concentration measured, criteria for using air-purifying respirators met, and skin and eye exposure is unlikely. Monitoring of the air must be performed to comply with OSHA regulations and to ensure respirator effectiveness.

- Full face, air-purifying respirator (MSHA/NIOSH approved) with cartridge type MSA/GMCH.
- Chemical resistant clothing (one-piece coverall; hooded, two-piece, chemical-splash suit, chemical resistant hood and apron, disposable chemical resistant coveralls).
- TLD badge for radiation (required for NUS personnel).
- Chemical resistant inner and outer gloves (latex inner, rubber outer).
- Boots, steel toe and shank, chemical-resistant.
- Hard hat.

Level D is primarily a work uniform. It should not be worn on any site where respiratory or skin hazards exist.

- Protective coveralls and protective gloves.
- TLD badge for radiation (required for NUS personnel).
- Boots or shoe with steel toe and shank.
- Hard hat.
- Safety eye wear.

TABLE 5-1

REQUIRED LEVEL(S) OF PROTECTION
MCAS, CHERRY POINT, NORTH CAROLINA

Task	Respiratory	Clothing	Gloves	Boots	Other Modifications
Team Leader	None to APR	Work uniform to Tyvek	Inner-L Outer-N	C	
Site Safety Officer	None to APR	Work uniform to Tyvek	Inner-L Outer-N	C	
Samplers	None to APR	Work uniform to Tyvek	Inner-L Outer-N	C	
Project Manager	None to APR	Work uniform to Tyvek	Inner-L Outer-N	C	
Drillers and Helpers	None to APR	Tyvek to PVC	Inner-L Outer-N	C	

B	=	Butyl
C	=	Covers
L	=	Latex
N	=	Nitrile
N	=	Neoprene
S	=	Saranex
T	=	Tyvek
V	=	Viton
Other	=	Other (specify)
TBD	=	To be Determined

6.0 AIR MONITORING AND ACTION LEVELS

6.1 AIR MONITORING REQUIREMENTS

An HNU PI-101 photoionization detector equipped with a 11.7 eV lamp will be utilized during all drilling and sampling operations to detect the presence of unexpected airborne chemical substances. Air monitoring shall be initiated in the head space of samples and/or boreholes. Any positive HNU readings at these locations will require monitoring of the workers' breathing zone and notification of the HSO. Positive HNU readings in the workers' breathing zone, or if odors are present, require immediate withdrawal from the affected area and notification of the NUS HSO and NUS Project Manager.

An LEL/O_2 meter shall be used to detect potential flammable atmospheres. Monitoring with the LEL/O_2 meter shall be conducted within the headspace of samples and boreholes. At 10 percent LEL, work shall proceed with caution, monitoring shall become more frequent, and drillers must use spark-proof tools. At 20 percent LEL in the head space of a sample or borehole, efforts must be undertaken to reduce levels before drilling can continue.

6.2 AIR MONITORING SELECTION CRITERIA

The HNU was selected as a precautionary measure to detect the presence of unexpected airborne chemical substances. The LEL/O_2 meter was selected to detect the presence of flammable atmospheres in the boreholes and, if necessary, in the work environment.

6.3 CALIBRATION CRITERIA

The HNU shall be calibrated before each day's use as per NUS SOPs and training.

The LEL/O_2 meter calibration shall be verified before each day's use. Internal calibrations will be conducted prior to being sent into the field.

6.4 OPERATING PROCEDURES AND METHODS FOR SURVEILLANCE

Air monitoring, using both the HNU photoionization detector and the MSA Model 260 LEL/O_2 meter, will be conducted during all tasks outlined in this HASP. Continuous monitoring will be conducted in the worker's breathing zone. If any readings are recorded during any site task, appropriate action will be taken as outlined in this section and Section 5.0, Personal Protective Equipment.

6.5 METHODS OF MAINTENANCE AND CALIBRATION

All equipment maintenance and calibration efforts shall be conducted by the NUS HSO at the MCAS, Cherry Point facility. These efforts shall be performed in accordance with the following NUS Health and Safety Standard Operating Procedures.

- Number MC01: Use, Calibration, and Maintenance of the HNU PI-101
- Number ME05: Combustible Gas Indicator

TABLE 6-1

OPERATIONS AND MONITORING/SAMPLING EQUIPMENT CHECKLIST
MCAS, CHERRY POINT, NORTH CAROLINA

Type of Equipment	Number Needed	Calibrated	Field Ready
HNU with 11.7 eV	1	Daily	
LEL/O_2 meter	1	Prior to startup	

7.0 SITE CONTROL MEASURES

Site control measures will be enforced at the Cherry Point facility during field activities to prevent or reduce the migration of potentially contaminated materials and to prevent the entry of unauthorized personnel into the applicable work area. A three-zone approach will be used to maintain site control.

Since there are various study areas in the total work area, it is anticipated that several site set-ups will be employed during field operations. The exclusion zone will be designated as the specific location where field activities, i.e., drilling, sampling, etc., are taking place. This area will be physically barricaded by the use of cones, survey tape, and/or flagging to serve as a visual indicator to site personnel to wear the prescribed PPE in the affected area. Physically marking the exclusion zone also will aid in controlling pedestrian traffic. As previously stated, various exclusion zones will be involved due to the size of the investigation area and the varying work locations. Each specific work location additionally will contain a personnel decontamination station as part of the contamination reduction zone.

The field activities support zone, where support facilities (i.e., a trailer, site vehicles, if applicable) will be located, will be in a controlled area on the property. This zone will be in an area where contamination is not suspected, and its exact location will be determined prior to site work. Personnel exiting any designated exclusion zone will be required to go through the prescribed level of decontamination before entering the support area. Additionally, the storage of any contaminated materials in the support zone will be expressly prohibited.

Decision-making criteria for each work area set-up takes into account the following:

- Site historical information.
- Suspected dimensions of the contaminated area.
- Physical and topographical features of the site.
- Weather conditions.
- Access requirements.
- Physical, chemical, toxicological, and other characteristics of the substances present.
- Clean-up activities required.
- Potential for fire.
- Area needed to conduct operations.

- Decontamination procedures.
- Potential for exposure.

The HSSO, in conjunction with the FOL, will determine the location of site zones prior to commencement of work in any given area. Personnel are to be advised that the three-zone approach involves a worst-case scenario. In situations involving negligible exposure potentials (i.e., surface activities), site zoning procedures will be minimal or inapplicable. In all instances, applicable information will be appropriately communicated to personnel.

8.0 SITE STANDARD OPERATING PROCEDURES (SOPs)

The following requirements and restrictions apply to all NUS site personnel (employees and subcontractors) conducting field activities at the Cherry Point facility.

- All personnel must meet Cherry Point contract requirements regarding health and safety.

- All personnel are responsible for complying with all applicable regulations (i.e., OSHA), for employing safe operating procedures while performing their duties.

- All personnel must procure a site-specific HASP from the HSSO prior to reporting to the site. A site safety follow-up report must be completed immediately upon trip completion by NUS personnel, and submitted to the HSSO. The site safety follow-up report form is located as Attachment A at the end of this HASP.

- All personnel must conduct their activities in a manner pursuant to the contents of this HASP and all of NUS' Health and Safety SOPs.

- All personnel must satisfy medical surveillance requirements.

- Any person using prescription or non-prescription drugs must first notify the HSSO so that it can be determined that they do not pose a potentiating hazard potential with site contaminants.

- No one may use cosmetics while on site as they can potentiate the effects of some chemical substances.

- Eating, drinking, smoking, chewing gum or tobacco, or any other hand-to-mouth activities are prohibited onsite due to the potential for contaminant ingestion.

- Upon leaving any designated exclusion zone, personnel must thoroughly wash their hands and face as soon as possible, following personnel decontamination.

- Any unnecessary contact with potentially-contaminated substances must be avoided. This includes contact with potentially-contaminated surfaces and/or equipment. Monitoring instruments and other hand-held items are not to be placed on ground surfaces or other potentially-contaminated surfaces.

- No facial hair, which can interfere with achieving a satisfactory face-to-facepiece seal with respiratory protective equipment, is permitted on any person required to use such equipment.

- Monitoring instrument action levels presented in this plan shall be observed.

- If personnel note any warning properties of chemicals (irritation, odors, symptoms as discussed in Table 4-1) or even remotely suspect the occurrence of exposure, they must immediately notify the HSSO for further direction.

- Work cessation due to electrical storms, extreme high ambient heat loads, or other such adverse weather conditions shall be determined by the HSSO and the FOL.

- No flames or open fires will be permitted on site without the prior knowledge and approval of the HSSO.

- Site personnel are not to undertake any activity which would be considered a confined-space entry without first being trained in the proper procedures by the HSSO.

- Any areas targeted for subsurface investigation must first be investigated to determine the presence of underground utilities. This information is to be documented in the project logbook.

- No drilling or other such activities will be conducted within a 20-foot radius of energized overhead power lines.

- No open pits will be left unattended, under any circumstances.

- All drill rigs and other machinery with exposed moving parts must be equipped with an operational emergency stop device. Drillers and geologists must be aware of the location of this device. The driller and helper shall not simultaneously handle moving augers or flights unless there is a standby person to activate the emergency stop.

- The driller must never leave the controls while the tools are rotating unless all personnel are clear of the rotating equipment.

- A long-handled shovel or equivalent must be used to clear drill cuttings away from the hole and from rotating tools. Hands and/or feet are not to be used for this purpose.

- A remote sampling device must be used to sample drill cuttings if the tools are rotating. Samplers must not reach into or near the rotating equipment. If personnel must work near any tools which could rotate, the driller must shut down the rig prior to initiating such work.

- Drillers, helpers, and samplers must secure all loose clothing when in the vicinity of drilling operations.

- Only equipment which has been approved by the manufacturer may be used in conjunction with site equipment and specifically to attach sections of drilling tools together. Pins that protrude from augers shall not be allowed.

- No person shall climb the drill mast while tools are rotating.

- No person shall climb the drill mast without the use of ANSI-approved fall protection (i.e., approved belts, lanyards, and a fall protection slide rail) or portable ladder which meets the requirements of OSHA standards.

- "All" compressed gas cylinders (empty or full) must be stored and used in an upright position, properly secured, and protected from damage.

- The site safety officer must make an entry into the Health and Safety Logbook each day, including monitoring instrument calibration logs.

- Appropriate training and medical monitoring records must be accessible for all site personnel including subcontractors.

- All site personnel including subcontractors must complete a medical data sheet, to be maintained on site.

- Site personnel must immediately notify NUS Health Sciences (the HSSO or HSO) of all incidents for OSHA recordkeeping purposes (Attachment B).

- The OSHA poster (Attachment C) must be posted at the job site.

9.0 CONFINED SPACE ENTRY (CSE) PROCEDURES

There are no confined space entry operations anticipated for this project, therefore, this section is not applicable.

10.0 MEDICAL/EMERGENCY INFORMATION

All subcontracting personnel whose presence is required on site must first be examined by a licensed physician (or under the supervision of a licensed physician) in accordance to OSHA standard 29 CFR 1910.120 and 1910.134. The physician's clearance for site work on the Cherry Point_site shall be documented, and reviewed by the OHSS before the individual(s) is (are) permitted to be onsite. NUS personnel, whose work may require their presence in areas where potential exposures to hazardous materials exist, shall participate in the NUS medical monitoring program as specified in the NUS Health and Safety Manual, Subject: Medical Program, Number HS-3.0. All medical examinations performed for NUS personnel and NUS subcontracting personnel for these purposes shall be conducted in accordance with OSHA General Industry standards 29 CFR 1910.120, and 1910.134.

Medical examination contents are at the discretion of the examining physician.

10.1 PROCEDURES FOR INCLEMENT WEATHER

No work conducted outside during electrical storms or any other extreme weather conditions.

10.2 EMERGENCY PROCEDURE FOR OVERT PERSONNEL EXPOSURE

- Skin Contact: Remove contaminated clothing. Wash immediately with water. Use soap if available.

- Inhalation: Remove from contaminated atmosphere. Artificial respiration if necessary. Transport to hospital.

- Ingestion: Never induce vomiting on an unconscious person. Also, never induce vomiting when acids, alkalis, or petroleum products are suspected. Contact the poison control center.

FIGURE 10-1

EMERGENCY REFERENCE (POST ONSITE)
MCAS, CHERRY POINT, NORTH CAROLINA

Site: MCAS, Cherry Point   Project No.: 4M97

Emergency Information:

Local Resources:		
Office:		
Ambulance (Name):	On Base	(919) 466-4419
Hospital (Name):	Craven Regional Medical Center	(919) 633-8111
Police (Local or State):	On Base	(919) 466-3615
Fire Department (Name):	On Base	(919) 466-3333
Nearest Phone:	TBA	TBA
Project Manager:	Debbie Wroblewski	(412) 788-1080 (office)
Site Health and Safety Officer:	Alan Margraf	(412) 788-1080 (office)
Alternate Site Health and Safety Officer:	TBA	TBA

Emergency Contacts (Medical and Health):

- Dr. Michael Hodgsen (NUS Consulting Physician - University of Pittsburgh)
  Office: (412) 648-3240
- Office Health and Safety Supervisor Matt Soltis, CSP
  Office: (412) 788-1080
- Program Manager of Health Sciences Richard Gerlach, Ph.D., CIH
  Office : (412) 788-1080
  Home:
- Poison Information Center: 1-800-672-1697
- National Response Center (for Environmental Emergency Only): 1-800-424-8802
- Office:

Directions to Hospital:

- Take Highway 70W to New Bern.
- Take Glenburnie Road Exit (right turn).
- Glenburnie to Neuse Blvd. (turn right).
- Two miles, hospital on left.
- Craven RMC, 2000 Neuse Blvd, New Bern.

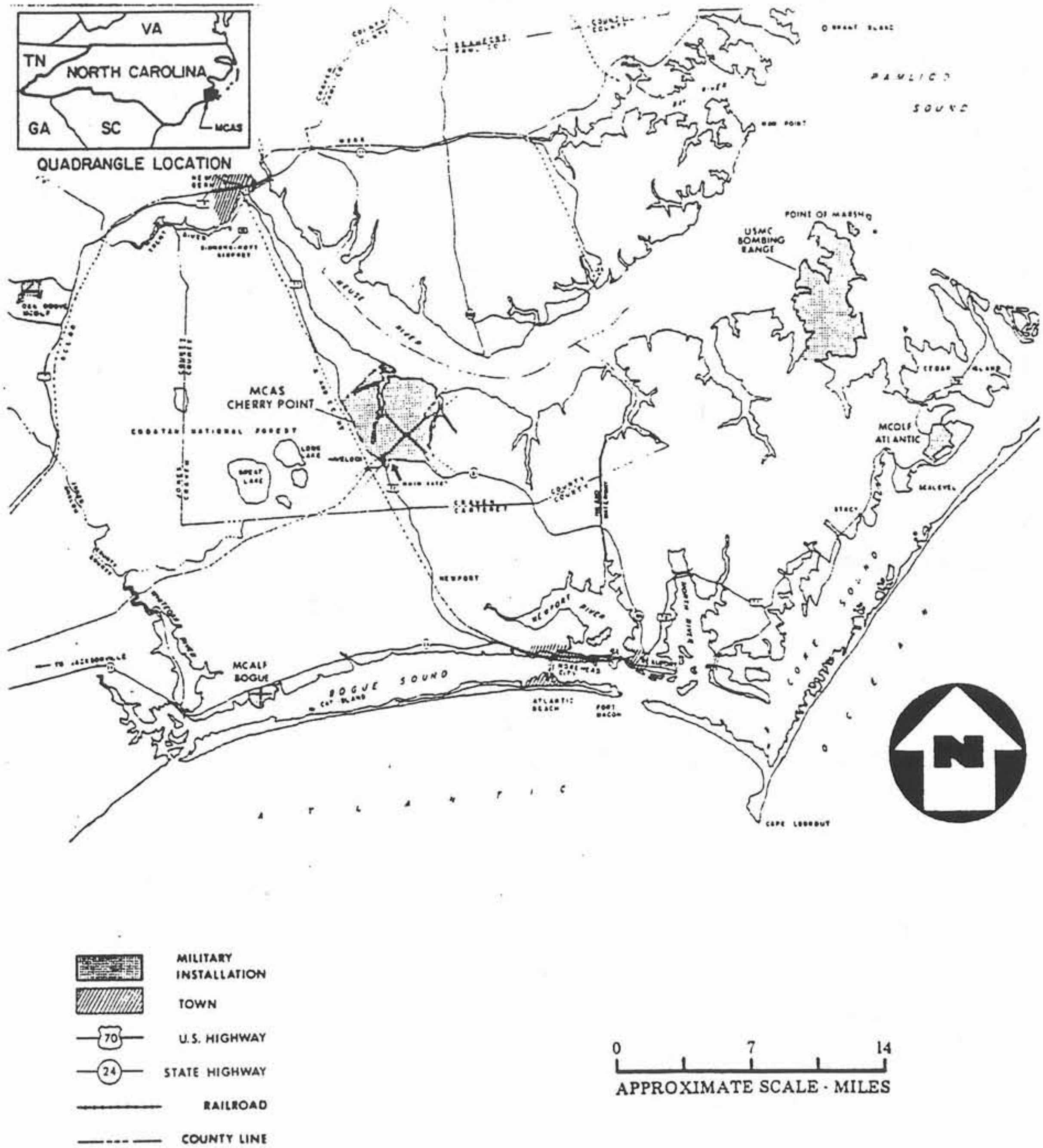


FIGURE 10-2

VICINITY MAP
MCAS CHERRY POINT, NC

NUS CORPORATION

FIGURE 10-3

FIRST AID AND EMERGENCY NUMBERS
MCAS, CHERRY POINT, NORTH CAROLINA

Emergency Resources

Ambulance	On Base	(919) 466-4419
Hospital (Emergency Room)	Craven RMC	(919) 633-8111
Fire	On Base	(919) 466-3333
Police	On Base	(919) 466-3615
Poison Control Center		1-800-672-1697
Airport		
Explosive Ordinance Disposal Unit		
Site Water Supply		
Site Telephone		
Site Radio		
Site Other	Hospital on Base (919) 466-5751	

Emergency Contacts

OHSS - Matt Soltis, CSP	(Day)	(412) 788-1080
	(Other)	
Office Physician - Dr. Hodgeson	(Office)	(412) 648-3240
	(Beeper)	
PMHS - Richard Gerlach, Ph.D., CIH	(Day)	(412) 788-1080
	(Other)	
WMSG Physician - Dr. Hodgeson	(Office)	(412) 648-3240
		Alternates: Dr. Betty Goodman - Kline

Hospital: Directions to Craven RMC

- Take Highway 70W to New Bern.
- Take Glenburnie Road Exit (right turn).
- Glenburnie to Neuse Blvd. (turn right).
- Two miles, hospital on left.
- Craven RMC, 2000 Neuse Blvd, New Bern.

Map attached? Yes X* No ______

* See Figure 10-2

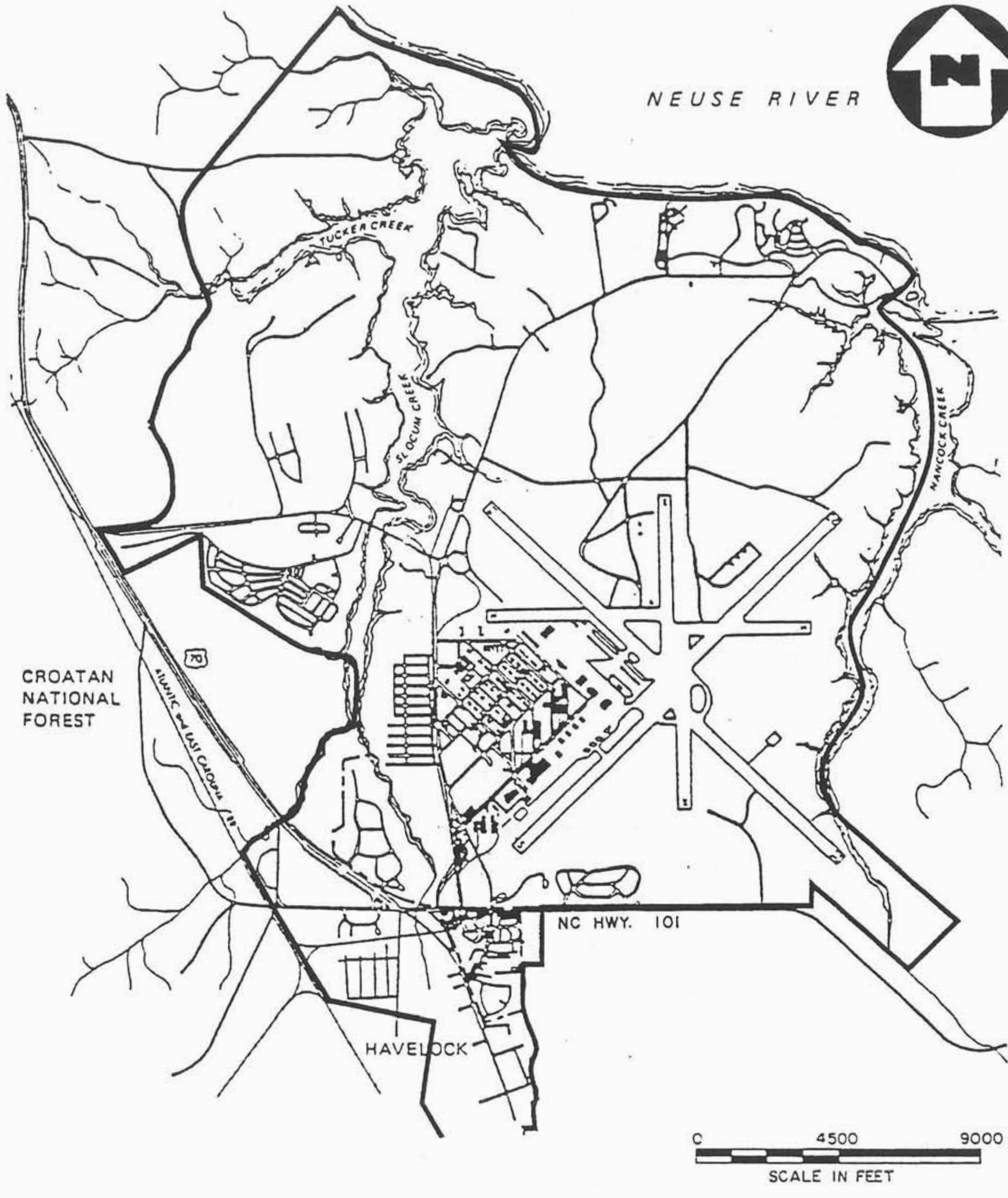


FIGURE 10-4

SITE LOCATION MAP
MCAS CHERRY POINT, NC

NUS CORPORATION

FIGURE 10-5

MEDICAL DATA SHEET
MCAS, CHERRY POINT, NORTH CAROLINA

This form must be completed by all onsite, personnel prior to the commencement of activities, and shall be kept in the site command post during site activities. This form must be delivered to any attending physician when medical assistance is needed.

Site ____

Name ______________________ Home Telephone (   ) ________

Address ____

Age ________ Height _____ Weight _____

Name of next of kin ____________________ Telephone (   ) ________

Drug allergies or other allergies ______________________________
____

Previous Illnesses or Exposures to Hazardous Substances:
____
____

Current Medication (prescription and non-prescription):
____
____

Medical Restrictions: ______________________________
____

Name, address and phone number of personal physician:
____
____
____

12.0 EMPLOYEE TRAINING ASSIGNMENTS

NUS employees must complete a 40-hour introductory health and safety training class held at the Pittsburgh Office. NUS subcontractors must also have 40 hours of introductory health and safety training as defined by OSHA Standard 29 CFR 1910.120.

Additionally, all NUS and subcontractor personnel must attend a training session before workers go on site. The training will consist of:

- Review of this HASP
- Basic chemistry and toxicology
- Work assignments and responsibilities
- Emergency provisions
- Communications setup
- Decontamination procedures
- Types of chemicals present on site and their effects
- Operational practices and protective requirements
- Respiratory protection

NUS personnel must also satisfy training requirements before going on site. In addition to the introductory training, other training may be required prior to initiation of activities. For example:

- Annual Health and Safety refresher training
- Supervisory Health and Safety training
- First Aid
- CPR

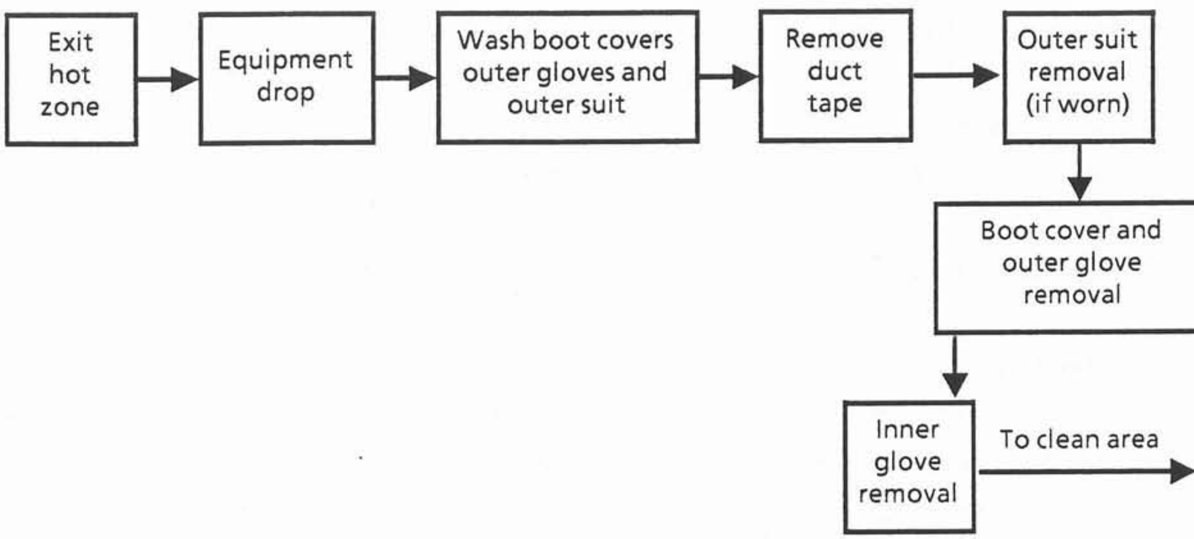
FIGURE 12-1

TRAINING CONDUCTED ON SITE
MCAS, CHERRY POINT, NORTH CAROLINA

Attendees	Subject-Coverage	Instructor	Date

11.0 DECONTAMINATION PROCEDURES

11.1 SKETCH OF DECONTAMINATION PROCEDURE



Explanation:

The sketch is for general decontamination procedures for operations at the MCAS, Cherry Point Site. The level of protection, concentration of chemicals (visual inspection), and other factors will determine the extent of decontamination. Decontamination procedures may have to be modified after work begins if site conditions warrant change.

11.2 DECONTAMINATION PROCEDURES

11.2.1 Personnel Decontamination Requirements

The decontamination of personnel and their protective clothing shall be performed in three stages. Stage 1 includes removing contamination from reusable protective clothing with a detergent/water solution and soft bristle scrub brushes. Stage 2 shall include removal protective clothing (disposable items shall be discarded into a container conspicuously marked "Potentially Contaminated Clothing"). Stage 3 shall consist of workers washing hands and face with potable water and soap each time they remove an item of PPE and/or leave the contaminated area.

11.3 DECONTAMINATION OF SAMPLING BOTTLES AND EQUIPMENT

All sampling equipment that will be leaving the site will require a thorough decontamination. This can be accomplished either by steam cleaning or by a detergent wash and potable water rinse until tools are visibly clean. Decontamination of sampling tools to prevent cross contamination of samples shall be performed in accordance with regional protocol, as described in the Work Plan.

11.4 DECONTAMINATION MODIFICATION (PERSONNEL, SURFACES, MATERIALS, INSTRUMENTS, EQUIPMENT, ETC.)

Decontamination procedures may be modified if deemed necessary. After work has begun at the site, however, the minimal decon procedures outlined above will be followed as minimal requirements. Emergency situations such as physical injury may warrant a lesser degree of decontamination, however, emergency personnel must be informed of the type of contamination they may encounter.

11.5 DISPOSAL PROCEDURES

On Site: Double bag, dispose as per Project Manager's direction.
Off Site: None anticipated.

13.0 EMERGENCY PLAN

13.1 ANTICIPATED SITE EMERGENCIES

Personal injury/illness is the only reasonably foreseeable emergency anticipated during site activities at the Cherry Point facility.

13.2 PERSONNEL ROLES AND LINES OF AUTHORITY

The NUS Field Team Leader (FTL) or Field Operations Leader (FOL) shall be responsible for the overall direction and implementation of this ERP, and for overall coordination of any emergency response actions.

The NUS site safety officer (SSO) shall serve as assistant and alternate to the FTL and shall provide health and safety input during emergencies.

The FTL or his alternate is responsible for notifying the appropriate outside emergency assistance, as needed, in accordance with Figure 10-1.

13.3 EMERGENCY RECOGNITION AND PREVENTION

Compliance with this HASP can assist in the prevention of anticipated site emergencies. These emergency situations can easily be recognized by visual observations, or worker complaints. Personnel will be working in close proximity to one another therefore eliminating the need for alarms or horns.

13.4 SAFE DISTANCES, PLACES OF REFUGE AND EVACUATION ROUTES

To be determined by the FTL/SSO on an emergency specific basis. Considerations shall include wind direction and site topography.

13.5 SITE SECURITY AND CONTROL

Site control measures are typically employed during site activities to prevent or reduce the migration of potentially contaminated materials and to prevent the entry of unauthorized personnel into the work area.

If NUS personnel or equipment are exposed to contamination, the project team shall ensure that proper decontamination procedures are followed. All decontamination liquids shall be contained to prevent migration outside the decontamination area.

The NUS project team shall be contained to prevent migration outside the decontamination area.

13.6 RESPONSE PROCEDURES

The information provided in this subsection is presented as a guideline to assist the FTL and SSO in safe and effective response to anticipated site emergencies. This information is in no way designed to take the place of reasonable decisions based on incident-specific information.

First Priority

Prevent further injury or illness by:

- Protecting response personnel
- Isolating the scene to authorized personnel only
- Rescuing the injured parties
- Notifying Outside Emergency Assistance

Second Priority

Provide first-aid to those persons with life threatening injuries or illnesses, using Appendx D as a guideline.

Third Priority

Alleviate the immediate hazards associated with the area of concern.

Fourth Priority

Provide first-aid to those persons with non-life threatening injuries or illnesses (Appendix D) and further efforts to alleviate the hazard.

Last Priority

Complete an incident report (Attachment B), critique the response and prevent recurrence.

All persons with known or suspected chemically related injuries or illnesses shall be immediately examined by a licensed physician. The examining physician may choose to consult with the NUS medical consultant for additional expertise on occupational injury/illness. Appendix E provides notification procedures to access this resource at any time of the day or night.

13.7 DECONTAMINATION AND FIRST-AID

Decontamination of injured or ill personnel shall consist of removing contaminated clothing. If worker's street clothes are grossly contaminated, remove them to prevent chemical exposures and wrap the injured party in a blanket.

First-aid shall be conducted by trained personnel.

13.8 EMERGENCY PHONE NUMBERS AND ROUTE TO HOSPITAL

Numbers shall be posted at the nearest available telephone.

All site personnel including subcontractors shall complete a medical data sheet and field team review. This form shall accompany any injured party to the hospital. This Medical Data Sheet can be found in Section 10.0, Figure 10-5.

Map to hospital can be found on Figure 10-2. Directions to hospital can be found on Figure 10-3.

13.9 SITE TOPOGRAPHY, LAYOUT, AND PREVAILING WEATHER CONDITIONS

See Figure 10-4.

13.10 PROCEDURES FOR CONTACTING LOCAL, STATE, AND FEDERAL AGENCIES TO REPORT SITE INCIDENTS

Will be performed by Field Team Leader.

13.11 EMPLOYEE ALARM SYSTEM

The following methods will be utilized to notify onsite personnel of the appropriate procedures.

Signal	
Verbal Commands	Work cessation
Verbal Commands	Onsite emergency situation
N/A	Lower background noise to speed communication
Verbal Commands	Beginning emergency procedures

Emergency First Aid Procedures (see Attachment D)

Other:

Administer necessary first aid (see attached American Red Cross information sheet), contact offsite medical facilities, implement Emergency Physician Access Plan (Attachment E).

14.0 FIELD TEAM REVIEW

FIELD TEAM REVIEW
MCAS, CHERRY POINT, NORTH CAROLINA

Must be signed by each field team member prior to the first site visit.

I have read and understand the contents of this HASP and will comply to its provisions, requirements, and restrictions.

Site ______________________________

Name (PRINT)	Signature	Date

ATTACHMENT A

FIELD TEAM REVIEW AND
SITE SAFETY
FOLLOW-UP REPORT

FIELD TEAM REVIEW

Must be signed by each field team member prior to the first site visit. This form must be copied to the HSO for inclusion in the project records.

I have read and understand the contents of this HASP and will comply to its provisions, requirements, and restrictions.

Site ______________________________

Name (PRINT)	Signature	Date

SITE SAFETY FOLLOW UP REPORT

This section must be filled out and returned to the Site Safety Officer after each site visit or task.

Person responsible for follow up report: ______________________________

Actual date of work: ______________________________

Actual Site Investigation Team:

NUS Personnel:	Responsibility:

Other:	Purpose:

PERSONAL PROTECTIVE EQUIPMENT

• Level of Respiratory Protection Used	Activity Performed

• Field Dress	Activity

MONITORING EQUIPMENT

HNU

- Background reading ______________________
  - Readings above background? ______________________
  - Location of high readings ______________________

____

____

Radiation

- Readings above background? _____ Yes _____ No
- If yes, specify where readings were found and what action was taken.

____

____

____

GENERAL SAFETY

Were any safety problems encountered while on site?

Explain: ____

____

____

____

____

____

____

____

ACCIDENT REPORT INFORMATION

Did any team member report:	Yes	No
• Chemical exposure		
• Illness, discomfort, or unusual symptoms		
• Environmental problems (heat, cold, etc.)		

Explain: ____

____

____

____

____

____

____

____

Was an Employee Exposure/Injury Incident Report Completed? ___ Yes ___ No

SITE SAFETY REVIEW - CHANGES AND OVERALL EVALUATION

(To be Completed for Each Field Change in Plan)

Was the Safety Plan Followed as presented? _____ yes _____ no

Describe, in detail, all changes to the Safety Plan:

____

____

____

____

____

Reason for changes: ____

____

____

____

____

Follow-up, Review and Evaluation Prepared by: ____________________ Date ____________

Discipline ______________________________

Approved by: Site Manager ____________________ Date ____________

Site Safety Officer ____________________ Date ____________

Approved by: Office Health & Safety Supervisor ____________________ Date ____________

Evaluation of Site Safety Plan

Was the Safety Plan adequate? _____ yes _____ no

What changes would you recommend?

____

____

____

____

HEAT STRESS MONITORING LOG

Date	Name	Work Shift		Total Time	Pulse Rate	Adjusted Air Temp.
		Start	Stop			

FIRST AID SUPPLY USAGE FORM

Project No.	Date	Item(s) Used	Kit No.

Please submit this form as soon as possible to to the NUS Equipment Manager for first aid supply replenishment.

SCBA LOG

Site: ______________________________

Location: ______________________________

Dates of Investigation: ______________________________

User	Date of Use	SCBA #	Satisfactory Check-Out (Yes/No - Initials)	Date Cleaned

SCBA Performance Comments:

______________________________ ______________________________
Site Manager Date

Return to HSO at Completion of Activity

(ULTRA TWIN)
RESPIRATOR LOG

Site: ____________________

Location: ____________________

Dates of Investigation: ____________________

User	Date of Use	Cleaned and Inspected Prior To Use (Initials)	Cartridges Changed Prior to Use (Yes/No)	Total Hours On Cartridge

____________________ ____________________

Site Manager Date

Return to HSO at Completion of Activity

ATTACHMENT B

INCIDENT REPORT

INCIDENT REPORT

Report No. ____________

Project No. ____________

Site: ____________________

Location: ____________________

Date of Report: ____________ Preparer's Name: ____________

Name and Address of Injured: ____________ SSN: ________ Age: ____

____________________ Sex: ____

Years of Service: ____ Time of Present Job: ____ Title/Classification: ____

Division/Department: ________ Date of Incident: ________ Time: ____

Incident Category: ____ Motor Vehicle ____ Property Damage ____ Fire

____ Chemical Exposure ____ Near Miss ____ Other

Severity of Injury or Illness: ____ Non-disabling ____ Disabling

____ Medical Treatment ____ Fatality

Amount of Damage: $ ________ Property Damage: ________

Estimated Number of Days Away from Job: ____________

Nature of Injury or Illness: ____________

<u>Classification of Injury</u>:

____	Fractures	____	Heat Burns	____	Cold Exposure
____	Dislocations	____	Chemical Burns	____	Frostbite
____	Sprains	____	Radiation Burns	____	Heat Stroke
____	Abrasions	____	Bruises	____	Heat Exhaustion
____	Lacerations	____	Blisters	____	Concussion
____	Punctures	____	Toxic Respiratory Exposure	____	Faint/Dizziness
____	Bites	____	Toxic Ingestion	____	Toxic Respiratory
____	Respiratory Allergy			____	Dermal Allergy

Part of Body Affected: ____________

Degree of Disability: ____________

Date Medical Care was Received: ____________

Where Medical Care was Received: ______________________________

Address (if off site): ______________________________

Incident Location

Causative agent most directly related to accident (object, substance, material, machinery, equipment, conditions): ______________________________

____

____

____

Was weather a factor? ______________________________

Unsafe mechanical/physical/environmental condition at time of accident (Be specific):

____

____

____

Unsafe act by injured and/or others contributing to the accident (Be specific, must be answered):

____

____

____

Personal factors (improper attitude, lack of knowledge or skill, slow reaction, fatigue):

____

____

____

Level of personal protection equipment required in Site Safety Plan:

____

____

____

Modifications: ______________________________

____

____

____

Was injured using required equipment: ______________________________

____

____

If not, how did actual equipment use differ from plan? ______________________________

____

____

____

What can be done to prevent a recurrence of this type of accident (modification of machine; mechanical guards; correct environment; training)?

____

____

____

Detailed narrative description (how did accident occur, why; objects, equipment tools used, circumstances, assigned duties). Be specific:

____

____

____

(Use back of sheet, as required)

Witnesses to accident: ____

____

____

Signature of Preparer ______________________

Signature of Site Manager ______________________

<u>Department Appraisal and Recommendation</u>

In your opinion, what actions or equipment contributed to this accident?

____

____

____

Your recommendation:

____

____

____

Date: __________ Signature of Department Manager ______________________

FOR HEALTH AND SAFETY USE ONLY

Temporary Total	________	Permanent Partial	________
Death or Permanent Total	________		
Started losing time	________	Part of Body	________
Returned to work	________	Percent loss or	
Time charge	________	loss of use	________
		Time charge	________
Compensation	$ ________	Medical	$ ________
Other	$ ________	total	$ ________

Name and Address
of Hospital ____________________
____

Name and Address
of Physician ____________________
____

cc: OHSS
Administrative Manager
HSO
Medical Consultant

INCIDENT FOLLOW-UP

Date of Incident: ____________________

Name: ____________________ Employee No. ____________________

Site: ____________________

Brief description of incident: ____________________

Outcome of incident: ____________________

Physician's recommendations: ____________________

Date returned to work: ____________________

ATTACH ANY ADDITIONAL INFORMATION TO THIS FORM

cc: OHSS
Administrative Manager
HSO
Medical Consultant

ATTACHMENT C

OSHA POSTER

JOB SAFETY & HEALTH PROTECTION

The Occupational Safety and Health Act of 1970 provides job safety and health protection for workers by promoting safe and healthful working conditions throughout the Nation. Requirements of the Act include the following:

Employers

All employers must furnish to employees employment and a place of employment free from recognized hazards that are causing or are likely to cause death or serious harm to employees. Employers must comply with occupational safety and health standards issued under the Act.

Employees

Employees must comply with all occupational safety and health standards, rules, regulations and orders issued under the Act that apply to their own actions and conduct on the job.

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor has the primary responsibility for administering the Act. OSHA issues occupational safety and health standards, and its Compliance Safety and Health Officers conduct jobsite inspections to help ensure compliance with the Act.

Inspection

The Act requires that a representative of the employer and a representative authorized by the employees be given an opportunity to accompany the OSHA inspector for the purpose of aiding the inspection.

Where there is no authorized employee representative, the OSHA Compliance Officer must consult with a reasonable number of employees concerning safety and health conditions in the workplace.

Complaint

Employees or their representatives have the right to file a complaint with the nearest OSHA office requesting an inspection if they believe unsafe or unhealthful conditions exist in their workplace. OSHA will withhold, on request, names of employees complaining.

The Act provides that employees may not be discharged or discriminated against in any way for filing safety and health complaints or for otherwise exercising their rights under the Act.

Employees who believe they have been discriminated against may file a complaint with their nearest OSHA office within 30 days of the alleged discrimination.

Citation

If upon inspection OSHA believes an employer has violated the Act, a citation alleging such violations will be issued to the employer. Each citation will specify a time period within which the alleged violation must be corrected.

The OSHA citation must be prominently displayed at or near the place of alleged violation for three days, or until it is corrected, whichever is later, to warn employees of dangers that may exist there.

Proposed Penalty

The Act provides for mandatory penalties against employers of up to \$1,000 for each serious violation and for optional penalties of up to \$1,000 for each nonserious violation. Penalties of up to \$1,000 per day may be proposed for failure to correct violations within the proposed time period. Also, any employer who willfully or repeatedly violates the Act may be assessed penalties of up to \$10,000 for each such violation.

Criminal penalties are also provided for in the Act. Any willful violation resulting in death of an employee, upon conviction, is punishable by a fine of not more than \$10,000, or by imprisonment for not more than six months, or by both. Conviction of an employer after a first conviction doubles these maximum penalties.

Voluntary Activity

While providing penalties for violations, the Act also encourages efforts by labor and management, before an OSHA inspection, to reduce workplace hazards voluntarily and to develop and improve safety and health programs in all workplaces and industries. OSHA's Voluntary Protection Programs recognize outstanding efforts of this nature.

Such voluntary action should initially focus on the identification and elimination of hazards that could cause death, injury, or illness to employees and supervisors. There are many public and private organizations that can provide information and assistance in this effort, if requested. Also, your local OSHA office can provide considerable help and advice on solving safety and health problems or can refer you to other sources for help such as training.

Consultation

Free consultative assistance, without citation or penalty, is available to employers, on request, through OSHA supported programs in most State departments of labor or health.

More Information

Additional information and copies of the Act, specific OSHA safety and health standards, and other applicable regulations may be obtained from your employer or from the nearest OSHA Regional Office in the following locations:

Atlanta, Georgia
Boston, Massachusetts
Chicago, Illinois
Dallas, Texas
Denver, Colorado
Kansas City, Missouri
New York, New York
Philadelphia, Pennsylvania
San Francisco, California
Seattle, Washington

Telephone numbers for these offices, and additional area office locations, are listed in the telephone directory under the United States Department of Labor in the United States Government listing.

Washington, D.C.
1988 (Revised)
OSHA 2203

Ann McLaughlin

Ann McLaughlin, Secretary of Labor

U.S. Department of Labor
Occupational Safety and Health Administration

Under provisions of Title 29, Code of Federal Regulations, Part 1903.2(a)(1) employers must post this notice (or a facsimile) in a conspicuous place where notices to employees are customarily posted.

GPO : 1988 O - 219-667

ATTACHMENT D

FIRST AID POSTER

Police:	(919) 466-3615
Fire Department:	(919) 466-3333
Doctor:	
Ambulance:	(919) 466-4419
Hospital:	(919) 247-1616
Poison Control Center:	800-672-1097

American Red Cross

First Aid

BITES Animal Bites - Thoroughly wash the wound with soap and water. Flush the area with running water and apply a sterile dressing. Immobilize affected part until the victim has been attended by a physician. See that the animal is kept alive and in quarantine. Obtain name and address of the owner of the animal.

Insect Bites - Remove "stinger" if present. Keep affected part down below the level of the heart. Apply ice bag. For minor bites and stings apply soothing lotions, such as calamine.

BURNS AND SCALDS Minor Burns - DO NOT APPLY VASELINE OR GREASE OF ANY KIND. Apply cold water applications until pain subsides. Cover with a dry, sterile gauze dressing. Do not break blisters or remove tissue. Seek medical attention.

Severe Burns - Do not remove adhered particles of clothing. Do not apply ice or immerse in cold water. Do not apply ointment, grease or vaseline. Cover burns with thick sterile dressings. Keep burned feet or legs elevated. Seek medical attention immediately.

Chemical Burns - Wash away the chemical soaked clothing with large amounts of water. Remove victim's chemical soaked clothing. If dry lime, brush away before flushing. Apply sterile dressing and seek medical attention.

CRAMPS Symptoms - Cramps in muscles of abdomen and extremities. Heat exhaustion may also be present.

Treatment - Same as for heat exhaustion.

CUTS Apply pressure with sterile gauze dressing, and elevate the area until bleeding stops. Apply a bandage and seek medical attention.

EYES Foreign Objects - Keep the victim from rubbing his his eye. Flush the eye with water. If flushing fails to remove the object, apply a dry, protective dressing and consult a physician.

Chemicals - Flood the eye thoroughly with water for 15 minutes. Cover the eye with a dry pad and seek medical attention.

FAINTING Keep the victim lying down. Loosen tight clothing. If victim vomits, roll him onto his side or turn his head to the side. If necessary wipe out his mouth. Maintain an open airway Bathe his face gently with cool water. Unless recovery is prompt, seek medical attention.

FRACTURES Deformity of an injured part usually means a fracture. If fracture is suspected, splint the part, DO NOT ATTEMPT TO MOVE INJURED PERSON; seek medical attention immediately.

FROSTBITE Symptoms - Just before frostbite occurs skin may be flushed, then change to white or grayish-yellow. Pain may be felt early then subsides. Blisters may appear, affected part feels very cold and numb.

Treatment - Bring victim indoors, cover the frozen area, provide extra clothing and blankets. Rewarm frozen area quickly by immersion in warm water---NOT HOT WATER. DO NOT RUB THE PART. Seek medical attention immediately.

HEAT EXHAUSTION Caused by exposure to heat - either sun or indoors. Symptoms - Near normal body temperature. Skin is pale and clammy. Profuse sweating, tiredness, weakness, headache, perhaps cramps, nausea, dizziness, and possible fainting.

Treatment - Keep in lying position and raise victim's feet. Loosen clothing, apply cool wet cloths. If conscious, give sips of salt water (1 teaspoon of salt per glass) over a period of one hour If vomiting occurs, discontinue the salt water. Seek medical attention immediately.

SUNSTROKE Symptoms - Body temperature is high (106 degrees F or higher). Skin is hot, red, and dry. Pulse is rapid and strong. Victim may be unconscious.

Treatment - Keep victim in lying position with head elevated. Remove clothing and repeatedly sponge the bare skin with cool water or rubbing alcohol. Seek medical attention immediately.

POISONING Call the poison control center for instruction on immediate care. If victim becomes unconscious, keep the airway open. If breathing stops give artificial respiration, by mouth to mouth breathing. Call an emergency squad as soon as possible.

POISON IVY Remove contaminated clothing; wash all exposed areas thoroughly with soap and water followed by rubbing alcohol. If rash is mild, apply calamine or other soothing skin lotion. If a severe reaction occurs, seek medical attention.

PUNCTURE WOUNDS If puncture wound is deeper than skin surface, seek medical attention. Serious infection can arise unless proper treatment is received.

SPRAINS Elevate injured part and apply ice bag or cold packs. DO NOT SOAK IN HOT WATER If pain and swelling persist, seek medical attention.

UNCONSCIOUSNESS Never attempt to give anything by mouth. Keep victim lying flat, maintain open airway If victim is not breathing provide artificial respiration by mouth to mouth breathing and call an emergency squad as soon as possible.

ATTACHMENT E

EMERGENCY PHYSICIAN ACCESS PLAN

EMERGENCY PHYSICIAN ACCESS PLAN

MCAS, CHERRY POINT, NORTH CAROLINA

(1) MONDAY THROUGH FRIDAY, 8:00 A.M. - 4:00 P.M. (Central Standard Time)

Dial the (412) 648-3240 number. When answered state that:

(a) you are calling from NUS Corporation;

(b) this is an emergency call.

Program staff will be alerted how to contact the physician designated to provide emergency coverage on that day. Collect calls will be accepted.

(2) EVENINGS, WEEKENDS AND HOLIDAYS:

Dial the (412) 648-3240 number. An operator from the answering service will answer the telephone. Do the following.

(a) Tell the operator that you are calling from NUS Corporation.

(b) Tell the operator that this is an emergency call.

(c) Give her your name.

(d) Give her the telephone number where the physician is to call. Be certain that she has written the correct number (area code and seven digits).

(e) If you do not receive a call back within 15 minutes, place a second call to (412) 648-3240.

Collect calls will be accepted.

(3) SITUATIONS WHERE EMPLOYEE REQUIRES IMMEDIATE TRANSPORT TO A HOSPITAL:

If the situation is life-threatening, i.e., cardiac arrest or person not breathing, call the emergency medical services system and transport the person to the nearest hospital with advanced life support capabilities.

- Report the accident to the Site Safety Officer, and the Office Health and Safety Supervisor
- Develop safe operating procedures to prevent a recurrence
- File incident report with HSO Pittsburgh, Pennsylvania